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Colorado River Salinity Control Program Federal Accomplishments Report for Fiscal Year 1993

presented to

Colorado River Basin Salinity Control Advisory Council

by

United States Department of Agriculture
Environmental Protection Agency
United States Fish and Wildlife Service
United States Geological Survey
Bureau of Land Management
Bureau of Reclamation

October 1993

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The purpose of this report is to report Federal accomplishments within the Colorado River Basin Salinity Control Program for fiscal year 1993 to the Colorado River Basin Salinity Control Advisory Council, as required by Public Law 93-320.

This report compiles accomplishment reports furnished by the Federal agencies associated with this program.

Contents

United States Department of Agriculture
Colorado River Basin Salinity Control Program
Accomplishments for Fiscal Year 1993

The United States Department of Agriculture (USDA) Colorado River Basin Salinity Control (CRSC) program is administered through the cooperative efforts of the Agricultural Research Service (ARS), Agricultural Stabilization and Conservation Service (ASCS), Cooperative State Research Service (CSRS), the Extension Service (ES), and the Soil Conservation Service (SCS). The USDA National Salinity Control Coordinating Committee coordinates these overall CRSC activities and provides this annual report of activities and accomplishments.

Funding

In fiscal year 1993, $13,783 million was appropriated for the USDA Colorado River Basin Salinity Control program. These funds were used for cost-sharing and technical assistance with participants; monitoring and evaluating impacts of the program; and for information and education activities. In addition, limited funds were used for salinity unit planning and investigations.

Status of Implementation

Because this report is being prepared prior to the end of fiscal year 1993, the indicated progress is based upon the best available information as of August 30, 1993. Additional salinity control contracts will be approved during September, the last month of the fiscal year. The cumulative salt reduction numbers will become available by the end of November. The accomplishments stated in this report result from the coordinated efforts of the indicated USDA agencies in administration of the program and in assisting participants to implement salinity reduction measures.

Big Sandy River, Wyoming

Implementation has been underway in this unit since 1988. During 1993, 14 new salinity control contracts were approved for a total of 62 salinity control contracts underway with farmers. There are 12 applications pending approval. The application of salinity reduction and wildlife habitat replacement practices is moving ahead very well. In this area, farmers are converting from surface flood irrigation to primarily low-pressure center pivot irrigation systems for salinity control. Twenty-one center pivot systems were installed by farmers in 1993. Information and education activities have been underway on alfalfa variety trials and promoting no-till methods to establish alfalfa.

Grand Valley, Colorado

Implementation has been underway in this unit since 1979. In 1993, 63 new contracts were approved for a total of 3,327 CRSC contracts and Agricultural Conservation Program (ACP) salinity/long-term agreements since the program began. There are 123 applications pending approval.

The application of salinity control and wildlife habitat replacement practices continues. Farmers are installing underground pipelines, gated pipe, concrete lined ditches, land leveling and a variety of other practices. The installation of surge irrigation systems continues to increase.

This is the final year for the surge demonstration and evaluation program being conducted with a grant from the Bureau of Reclamation (Reclamation). One hundred and thirty-five surge units have been installed by farmers under this program. Evaluation results show significant reductions in deep percolation from surge irrigation. Since this demonstration program started, 240 additional surge units have been installed by salinity control participants. A spin-off of the surge demonstration program is fertigation, which involves applying liquid nitrogen fertilizer during the soak stage of irrigation. Acceptance of this practice is an additional incentive for farmers to install surge systems. A minimum tillage field demonstration was conducted on irrigated cropland to evaluate the effects on water quality, crop productivity, and farm economics. Monitored parameters included: water use, infiltration, deep percolation, surface runoff, and runoff water quality.

Lower Gunnison Basin, Colorado

This is the largest of the USDA salinity control units and is located in Delta and Montrose counties. Implementation was initiated in 1988 in this unit. During 1993, 70 new contracts were approved, for a total of 219 contracts. There are 407 applications pending approval.

The application of salinity reduction and wildlife habitat replacement practices is rapidly increasing now that the total Lower Gunnison unit is under implementation. The major practices are underground pipelines, ditch lining, land leveling, irrigation water control structures, gated pipe, sprinkler and surge irrigation systems.

This was the second year of the USDA/Reclamation surge irrigation demonstration project, with 80 farmers participating. Two special newspaper editions on the salinity control program were published, and 18 organizations and agencies cooperated to hold a one-day "Water Festival" for 4th and 5th grade students in each county. Over 800 students attended this event, which will be held annually. Booths with information on the salinity program were set up at the county fair and various field days and tours were held. On one of the field days, Congressional representation from the both the House and Senate were present. The State Representative for that district was also present and addressed the gathering.

Uinta Basin, Utah

Implementation began in this unit in 1980. During 1993, 130 new contracts were approved in the two counties for a total of 1500 CRSC contracts and ACP salinity/long-term agreements since the program began. There are 450 applications pending approval.

The rate of applying salinity reduction and wildlife habitat replacement practices continues to increase. The major practices installed are sprinkler irrigation systems, improved surface systems, underground pipelines and gated pipe. In this area, a large number of groups are replacing earthen laterals with pipelines to provide gravity pressure for onfarm sprinkler systems.

A demonstration plot is being established on Ute Indian Tribal land to: illustrate the benefits of sprinkler irrigation; teach principles of irrigation scheduling; and provide data on crop variations, yields, and costs to determine fair market lease agreements. A sprinkler irrigation demonstration and field day was conducted for the Ute Indian Tribe. Special emphasis is being placed on working with individual farmers on principles of irrigation water management.

In August, a special field review of the wildlife habitat replacement activities was conducted to address wildlife habitat replacement concerns, including the tracking system. Representatives from EPA, FWS, ASCS, CES, SCS, and the Colorado River Basin Salinity Control Forum (Forum) attended. An action plan is being developed to address the concerns identified during the field review.

McElmo Creek, Colorado

Implementation was initiated in this unit in 1990. In 1993, 47 new contracts were approved for a total of 138 contracts. There are 290 applications pending approval.

Application of salinity reduction and wildlife habitat replacement practices is well underway in this area with sprinkler systems, underground pipelines, and gated pipe being installed. During 1993, Reclamation installed piped laterals off the Towaoc-Highline Canal to replace the Rocky Ford Lateral. This action required many farmers within the service area to install onfarm gravity sprinkler systems. Close cooperative interagency actions resulted in a well-coordinated process to implement this significant construction activity.

The *1993 Southwestern Colorado Irrigation Guide* was published and widely distributed during the year. In addition to specific guidance for water management, the guide includes a calendar of agricultural events, instructions on how to read various water measuring devices and other information.

Development of the automatic shutoff valve for sprinkler systems continued. To date, 18 valves have been installed by participants to help achieve irrigation water management. A demonstration project is underway using drip irrigation to show the effects of different application rates on beans and wheat.

Planning and Investigations

Price-San Rafael, Utah

USDA and Reclamation have prepared a draft planning report and environmental impact statement (PR/EIS) for the Price-San Rafael Rivers Unit. During 1993, responses to comments on USDA voluntary wildlife habitat replacement program were made, and the final report is now being prepared.

Moapa Valley, Nevada

The Moapa Valley final plan/EIS was issued in January 1993 and the Record of Decision (ROD) was published February 26, 1993.

Engineering designs have been completed for the beginning segments of the irrigation water distribution system. Many local meetings were held in the planning process. More recently, information and educational meetings have been held to discuss implementation actions. A weather station has been installed and local climatological data is being recorded to determine irrigation water needs for crops in the Moapa Valley.

San Juan River, New Mexico

A salinity investigation has been completed on irrigated lands along the San Juan River in New Mexico from the vicinity of Fruitland, westward to Cudei. This area, consisting of about 8,400 irrigated acres within the boundaries of the Navajo Nation. Findings from the investigation were published in a verification report this year. The conclusions and recommendations will be presented to the Colorado River Basin Salinity Control Forum Work Group during the October meeting.

Special Activities

A USDA salinity control program video was completed in 1993. It included footage from each of the active salinity control units and interviews with farmers who are participating in the program. The video was widely distributed to various agencies and organizations. Copies were provided to USDA offices in each of the salinity units and to the Forum and Work Group.

The USDA National Salinity Control Coordinating Committee prepared the *1993 Report To Congress*. This five-year report was submitted to Congress as required by the Colorado River Basin Salinity Control Act of 1974, as amended. It provides information on the program objectives, scope, and implementation impacts.

Monitoring and Evaluation

Monitoring and evaluation activities are underway in the Grand Valley, Uinta Basin, Big Sandy River, Lower Gunnison Basin, McElmo Creek, and Moapa Valley units. Under this activity, USDA is monitoring the effects of the salinity control program on salt load reductions and wildlife habitat as well as the program's economic impacts. An annual report is prepared for each unit to provide information on the monitoring and evaluation activities. Special efforts continue to refine the methods to monitor and track the effects of program implementation on wetlands and other wildlife habitat.

Rangelands

In Wyoming, USDA agencies cooperated with the Bureau of Land Management (BLM) and other agencies to identify the high priority rangeland watersheds for salinity control.

Concluding Comments

At the present time, over 1280 farmers have applications pending approval in the USDA Colorado River Basin Salinity Control program. This indicates the continued willingness of farmers to participate in the program. The USDA National Salinity Coordinating Committee is especially pleased to report that farmers are moving ahead rapidly with the application of salinity reduction practices.

Environmental Protection Agency
Colorado River Basin Salinity Control Program
Accomplishments for fiscal year 1993

During fiscal year 1993, the Environmental Protection Agency (EPA) focused its Colorado River Basin Salinity Control Program efforts on four major activities:

- providing assistance on development of the 1993 Colorado River salinity standards triennial review (1993 Review);
- poviding reviews under the National Environmental Policy Act (NEPA) for several salinity projects;
- coordinating with the Soil Conservation Service (SCS) and U.S. Fish and Wildlife Service (USFWS) to address wetland replacement concerns related to onfarm salinity activities; and
- implementing an interagency agreement between EPA and the Agricultural Research Service (ARS) to develop techniques for identifying sources and quantifying the quality of runoff water with respect to salinity from rangelands in the Colorado River Basin.

EPA has requested that additional information be included in the 1993 Review regarding adequacy of the salinity control plan of implementation in protecting the beneficial uses of the Colorado River under various projected hydrologic conditions and sequences. Most notably, this information would describe the magnitude, frequency, and duration that salinity levels are projected to exceed the numeric criteria. EPA is concerned that describing the adequacy of the plan of implementation on the basis of salinity adjusted to long-term (multi-year) mean flow conditions can conceal the extent of annual variability of salinity and how adversely affected the beneficial uses will be. Although we have raised these questions, we have not been satisfied with the responses.

Comments were provided on the final EIS for the Moapa Valley Unit of the onfarm salinity program. EPA provided written and verbal comments on the draft responses to EPA comments on the draft EIS for the Price-San Rafael Rivers Unit. Comments were provided to the Bureau of Reclamation (Reclamation), and a meeting was held on the preliminary draft environmental assessment for the Hammond area of the San Juan River Basin Unit.

EPA continued to address recommendations of the Colorado River Basin Salinity Control Advisory Council for coordination on wildlife habitat replacement issues on the USDA onfarm salinity program. An action plan between EPA and the Soil Conservation Service (SCS) was completed. Under the action plan, a field review of the wetland replacement program was held in the Uinta Basin Unit in August 1993. Participating agencies included the SCS, USFWS, the Agricultural Stabilization and Conservation Service, Extension Service, EPA, and a Forum representative. Two of the major topics discussed were the large disparity between the relatively small amount of replacement wetlands that have been installed compared to the approximately 1600 acres of wetlands lost to date, and the lack of an appropriate habitat evaluation model for the majority of wetlands being lost in the Uinta Basin Unit. The discussion comments and follow-up items were being prepared by the USDA and will be distributed when available. Additional efforts will be needed in fiscal year 1994 to catch up on the milestones in the action plan because of significant slippage in fiscal year 1993.

Through an interagency agreement with EPA funding, Reclamation completed a search of available literature and prepared a report on the functions of wetlands enhanced or created by irrigation. In addition, EPA's Corvallis Environmental Research Laboratory completed the first year of a study to: (1) assess the functions of irrigation-induced and/or enhanced wetlands and (2) develop a procedure using indicators to determine the functions for these types of wetlands. The production of a publication entitled *Irrigated Wetlands of the Colorado Plateau: Information Syntheses and Habitat Evaluation Method* was completed under this project.

The first year of the three-year interagency agreement with ARS was completed, and the EPA funds have been expended. The project is designed to: (1) assess the state of knowledge of salinity transport in rangeland runoff in the Colorado River Basin; (2) develop and field-verify techniques for correlating salinity of runoff water to sediment production estimates; and (3) develop techniques for identifying salinity sources by chemical ion balances from multiple inflows for estimating the effectiveness of selected range management practices on reducing salt. This information is important in the process of including salinity into the new Water Erosion Prediction Project (WEPP) model for rangeland. The report under activity (1) has been completed. Unfortunately, work under this interagency agreement has been suspended pending receipt of sufficient funding from the benefiting Federal agencies.

There are several other activities to report.

- The Region 8 and 9 Offices of EPA continued to provide assistance to the ground-water contamination study in the Aneth area of south-eastern Utah. Assistance consisted of technical review of draft reports and organization of Aneth Field Technical Committee meetings. EPA provided partial funding for the project in fiscal year 1992.

- Utah's readoption of the water quality standards for salinity (in response to the Forum's 1990 triennial review) was approved by EPA. Thus, EPA approval of readoption actions was completed for all Basin States.

- EPA Region 9 prepared extensive comments on Reclamation's Draft Preliminary Findings Report for the Lower Virgin River Project.

- The Colorado River Basin Salinity Control Program was promoted as a model of an integrated, holistic approach to solving water quality problems as EPA continued to implement the Watershed Protection Approach initiative.

- EPA participated in the various meetings of the Colorado River Basin Salinity Control Program.

Fish and Wildlife Service
Colorado River Basin Salinity Control Program
Accomplishments for Fiscal Year 1993

The Fish and Wildlife Service (Service) participated as a member of the steering committee that coordinated the efforts of a task group that ranked 76 watersheds within Wyoming for potential salinity control opportunities. The ranking process followed the Colorado Watershed Ranking Procedures. The task group met in July and have produced a draft Wyoming watershed ranking report. The Service is presently reviewing that report.

The Record of Decision (ROD) for the Moapa Valley Unit, Nevada, was issued February 22, 1993. The Soil Conservation Service (SCS) proposes to implement the recommended plan of action. The Service's Nevada State Office had expressed concern regarding the lack of assurance that compensation would be provided for impacts to wetlands lost as a result of the project. The ROD states that this issue was addressed in the Environmental Impact Statement (EIS) by the legislatively mandated voluntary replacement program, which includes all participants as well as the Overton Wildlife Management Area. The Final EIS did not expand the section on cumulative losses in the Moapa Valley through past actions, as recommended by the Service, stating that this would be beyond the scope of the document.

SCS has coordinated with the Service on conducting a Habitat Evaluation Procedure for the study area since the Final EIS was issued.

The Bureau of Reclamation's (BR) preliminary findings study of the lower Virgin River Unit project for salinity control and water resource development involves a cooperative effort between the Las Vegas Valley Water District (District) and BR to divert water from the Virgin River basin to the Las Vegas Valley area for municipal use. The Service has been working with BR pursuant to the Fish and Wildlife Coordination Act and has served on the Water Supply Work Group, an ad hoc committee of technical representatives formed by BR planning branch for the project. BR completed a Preliminary Findings Report on the project, which involves a diversion structure and reservoir near Halfway Wash, Nevada. The Service provided input to BR during the preparation of the report. This involved participating in the scoping meetings and review and comment on the draft and final documents. The Service expressed concerns about possible impacts to endangered and threatened species, riparian communities, and the enhancement of non-native fish populations as a consequence of the project. Although BR has yet to announce its decision, discussions with District staff indicate that BR may determine the project is not feasible. The District is expected to pursue the project independently to preserve their priority date for diversion of Virgin River water. However, they may attempt to wheel the Virgin River water into Lake Mead and remove it using existing Saddle Island pumping facilities.

A meeting was held on April 30, 1993, in Reclamation's Denver office to discuss outstanding wetland issues for the Hammond Project. At the meeting, BR presented sections of the Preliminary Team Draft, Draft Planning Report/Environmental Assessment. This draft document indicated that mitigation would be provided for the loss of wetland/riparian habitat within the canal rights-of-way. The draft document also indicated that other wetland losses would be monitored and mitigated later. The Service prepared a memo providing new mitigation recommendations. To date no response has been received.

In April of 1993, the Service received a revised draft wildlife development plan for the Colorado River Wildlife Area. On May 4, 1993, we met with BR, CDOW, and CDOPOR to discuss and refine details of the development plan. The "plan" was subsequently finalized in June of 1993. The Service continues to monitor implementation of the development plan and expects to begin working with Grand Junction Projects Office staff and CDOW on the fish and wildlife management plan for this property during the 4th quarter.

The Service continues to monitor habitat improvements at Horsethief Canyon Wildlife Area. Wetlands development and management for a diversity of species is progressing.

Overall mitigation planning for the Grand Valley Unit continues with both BR and SCS (onfarm) towards fulfillment of each agency's full mitigation commitments. Wildlife habitat replacement remains problematic with the SCS onfarm program. In April of 1993, BR prepared a Meeting/Correspondence History of wildlife habitat replacement issues associated with the Grand Valley Unit. Accomplishments of the SCS voluntary habitat replacement program have been minimal. To date, salinity improvements are approximately 60 percent completed, while less than 150 acres of the total 1,200-acre SCS commitment for wildlife improvements have been installed.

The Service has recommended that BR underwrite the SCS mitigation commitment and acquire and develop approximately 400 acres of wildlife habitat to bring wildlife mitigation requirements concurrent with project salinity improvements.

The Service has still not received written concurrence that BR will accept this recommendation.

The Service made a presentation to the American Society of Civil Engineers National Conference on Irrigation and Drainage Engineering, noting the difficulties met in the Salinity Control Program with wetland replacement and with agency conflicting mandates that will require multi-agency resolution.

On-the-ground review and discussions in the Uintah Basin on August 17-18 addressed the issues of wetland losses occasioned by the Salinity Control Program, evaluation procedures, and the SCS voluntary replacement program. Participants included: Environmental Protection Agency, Utah Division of Wildlife Resources, Soil Conservation Service, Agricultural Stabilization and Conservation Service, County Extension Service, Colorado River Basin Salinity Control Forum, and the

Service. Two days of frank discussions resulted in a number of agency commitments that would address the issues of wetland habitat loss and replacement evaluations and monitoring: HEP would continue to be the basis for SCS evaluations for the Uinta Basin Salinity Control Unit; SCS would provide additional monitoring data on wetland types (Circular 39) to EPA; SCS would update wetland acreage losses presently or anticipated to occur as related to that identified in the Final EIS; and all agencies will examine their prospective program authorities to implement processes that would make the voluntary replacement program more effective including: increasing cost sharing ratios, the state participating in cost sharing wetland replacement program on state owned lands, use of FMHA leased inventory properties as wetland replacement sites, and others.

United States Geological Survey
Colorado River Basin Salinity Control Program
Accomplishments for Fiscal Year 1993

Arizona

Five projects of potential interest to Colorado River basin water-resource planners and managers were described in last year's report to the Advisory Council. These projects are ongoing and Fiscal Year 1993 activities are discussed below. Reports from these projects were identified in the USGS's Fiscal Year 1992 report.

Puerco River Project

This four-year study of the occurrence and movement of radionuclides and trace metals in the Little Colorado River basin ended in FY92, pending completion of final reports. Sediment loads and contaminant discharges to the Colorado River have been calculated for discharges measured at the Little Colorado River near the Cameron, Arizona gauging station. A historical data report and two journal articles were published in 1991 and 1992, respectively. Two interpretive reports, a data report, and a non-technical summary are in the review and publication process.

Consumptive Use Project

Specific project objectives included: (1) estimating the amount of tributary inflow between Hoover Dam and the international boundary with Mexico for use in a water budget and suggesting ways of incorporating tributary inflow in the process of accounting for consumptive use and (2) developing an accounting system for consumptive use among diverters, points of diversion, and States adjacent to the lower Colorado River between Hoover Dam and the international boundary with Mexico. This project is completed, and the report has been approved for publication.

Regulatory Surface Project

The purpose of the Lower Colorado Regulatory Surface study is to improve water accounting by developing a method to identify wells that yield water that originated from or that will be replaced by water from the Colorado River. The objectives of this study are to: (1) delineate the limits of the stream-aquifer system in the lower Colorado River valley and those adjacent basins that have significant subsurface hydraulic connection to the stream-aquifer system of the Colorado River; (2) define the geometry, altitude, and boundaries of a potentiometric surface (accounting surface) within the area delineated in (1), below which water is presumed to be diverted from the Colorado River by pumping from wells; and (3) provide a tabulation of the inventoried wells within the accounting surface boundary.

Fieldwork began in FY90 and is continuing. More than 1,000 wells have been inventoried and entered in the Ground-Water Site Inventory data base. New aerial photographs for the area have been obtained. The subsurface limits of the river aquifer have been delineated in four localities by a gravity survey and from geologic and hydrologic information in the rest of the area. The potentiometric surface of the river aquifer is being defined with water levels of wetlands and wells and with river profiles of the projected annual highest monthly discharge for 1992-2001. Preliminary sets of maps showing the accounting surface will be available during FY93.

Dissolved Solids Estimation Project

The objectives of this project were to: (1) determine the availability and completeness of discharge and water-quality records for selected sites on the lower Colorado River from Imperial Dam to the southerly international boundary with Mexico; (2) develop techniques to estimate missing periods of records for discharge and dissolved solids; and (3) present monthly discharge and monthly dissolved-solids discharge for sites on the lower Colorado River from 1935 to the present. The District estimates the final report will be approved during FY94.

Glen Canyon Environmental Studies Projects

The Arizona District has been involved in evaluating the effects of Glen Canyon Dam operations on the hydraulics and sedimentation characteristics of the Colorado River through Grand Canyon National Park. Currently, four major projects are underway in cooperation with the Bureau of Reclamation.

a. **Beach Evolution Project**. The objective of this project is to gain an understanding of the status and evolution of sand bars used as camping sites and as substrate for riparian vegetation, thus enabling the prediction of how future releases from Glen Canyon Dam will affect the sand bars. The objective is being addressed by five study elements: (1) inventorying sand in sand bars or sand available for rebuilding of bars; (2) developing a descriptive understanding of the evolution of sand bars; (3) evaluating the effect of debris flows in tributary canyons on sand bars; (4) determining the significance of ground-water movement into and out of sand bars on the stability of the bars; and (5) developing predictive models for sand bar evolution. Activities in these elements through 1993 included: (1) seismic surveys, drilling, and bathymetric surveys to determine the aerial extent and thickness of sand deposits; (2) determining the depositional history of several bars by examination of internal sedimentary features; (3) monitoring several sand bars downstream from recent debris flows; (4) instrumentation and monitoring instrumentation to measure ground-water flow and slope movement at three sites; and (5) development and initial verification with laboratory data of a physically-based model for eddy flow.

b. **Sediment Transport Project**. The objective of this project is to develop sand-transport models for the canyon that will accurately reproduce all pertinent processes and enable prediction of the effects of various dam operation scenarios on transport of sand. Models will provide the boundary conditions for eddy models of the Beach Evolution Project. Three models are required: a surface-water flow model, a model for transport of conservative solutes, and a sand-transport model. Prediction of sand in the canyon due to dam operations also required the prediction of sediment inputs from tributaries. Activities through 1993 included: (1) measuring channel geometry and bed roughness in selected reaches; (2) measuring mass transport at two flow conditions using a dye tracer; (3) installing a dense network of stage gauges (about 50) and monitoring along the 300-mile reach; (4) measuring detailed suspended-sediment fields at a gauged station 3for a variety of flow conditions; and (5) initial development of one unsteady-flow model for the prediction of discharge throughout the study reach.

c. **Lake Powell Water Quality Project.** A report on data collected in 1991 was prepared in 1992. Initiation of long-term monitoring and research in Lake Powell began in 1992 and continued in 1993. Physical, chemical, and biological processes in tributaries to the lake are being studied to determine their significance and affects on the main body of Lake Powell.

d. **Hydrologic Data and Data-Base Management.** This project involves the collection of stage, discharge, and some physical characteristics of water at six Colorado River mainstem gauging stations and five gauging stations on tributaries of the Colorado River between Glen Canyon Dam and Lake Mead. During 1993, all tributary gauges, except on Havasu Creek and the gauge below the dam and above National Canyon on the Colorado River, were discontinued. Also, data from a network of stage sensors are collected and stored. All data are stored in a computer data base available to users of hydrologic data.

Colorado

As part of the cooperative effort between the U.S. Geological Survey and the Bureau of Reclamation to maintain and update a salinity data base and statistical analysis of data for the Colorado River basin, a regression procedure was developed to estimate dissolved-solids concentration at the Station, Colorado River at Grand Canyon (sampling was discontinued in 1987). In addition, the following projects are ongoing.

Irigation Drainage Reconnaissance Study of the Dolores Project

The Dolores Project diverts water from the Dolores River (from McPhee Reservoir) for irrigation in the San Juan Basin. The Project delivers water to areas that have never been irrigated, including about 7,500 acres of land on the Ute Mountain Ute Indian Reservation, and also delivers supplemental water to Montezuma Valley, which has been irrigated for nearly 100 years. Water-quality problems are related to the long-term irrigation in the McElmo Creek basin. Fish samples collected in the study area indicate potential problems of mercury contamination.

Samples collected in the spring of 1990 (pre-irrigation season) from old and new irrigated areas and at background sites had dissolved-solids concentrations greater than 1,000 milligrams per liter (mg/L). Selenium was greater than 10 micrograms per liter (ug/L) in only three samples. The highest selenium concentration (88 ug/L) was a sample from Navajo Wash near Towaoc, which drains some of the area of long-term irrigation south of Cortez.

All data collection has been completed, and the final report is in final technical review.

Irrigation Drainage Reconnaissance of the Pine River Area, Southern Ute Indian Reservation

Large concentrations of selenium in ground water have been reported on parts of the Southern Ute Indian Reservation. A documented case of human selenium poisoning caused by drinking well water occurred in 1962. Livestock poisoning is reported occasionally on the reservation. These areas also receive irrigation water from the Federal Pine River Project.

This study evaluated the Pine River Project to determine if irrigation drainage is contributing selenium, other trace elements, and pesticides to water, bottom sediments, and biota. Ground water in the Ignacio-Oxford area and near Arboles was sampled for selenium.

All data collection has been completed, and a report is published.

Animas Valley Methane Study

This study will map the distribution of and determine the sources and migration pathways of methane in shallow ground water of the Animas River Valley between Durango, Colorado, and Aztec, New Mexico. Between August 1990 and May 1991, methane concentrations were measured in 205 ground-water samples, 192 soil columns at ground-water sites, and 352 soil columns by gas-well casings. In addition, gas samples were collected from 16 water samples, three open-field soil seeps, 11 soil columns adjacent to gas-well casings, and 30 gas wells for analysis of molecular and isotopic composition. The latter samples were collected to provide information about possible sources of methane.

Two reports have been prepared covering this study. A Water Resources Investigations Report describing how data were collected and listing the data is published. An interpretative report has been reviewed and is being prepared for approval to publish.

Irrigation Drainage Detailed Study of the Lower Gunnison and Grand Valley Areas

The Gunnison and Uncompahgre Rivers and Sweitzer Lake in west-central Colorado were selected for a reconnaissance investigation in 1987 to evaluate potential water-quality problems related to Reclamation's Uncompahgre Project. Existing data indicated that the Uncompahgre Project area may contribute large amounts of selenium and possibly other toxic contaminants to streams and other water bodies. The investigation team for the study performed in 1987-88 was made up of representatives from the U.S. Geological Survey, Fish and Wildlife Service, and Reclamation. The report describing the results of the investigation was released in 1991.

The results of the reconnaissance investigation indicated that the Uncompahgre Project was a significant source of selenium. A detailed study was initiated in 1991 to determine source areas of selenium, geochemical processes affecting selenium concentrations in water and to document effects to biota. Grand Valley is a significant source of salt to the Colorado River, and the geologic formation that is the source of the salt also is a likely source of selenium. Therefore, Grand Valley was included in the detailed study of the Uncompahgre Project.

Data collection for the detailed study was initiated in March 1991 and was concluded in August 1992. Sampling included collection of surface-water, ground-water, soil, bottom-sediment, and various types of biological samples. Mineralogic analyses were done on drill cores and some soil samples. The data report is scheduled for publication in 1993. An interpretative report describing the results of the study is scheduled for publication in 1994.

Nevada

Salt Load Estimates from Public Lands

The project, conducted with Bureau of Land Management support, was described in detail in the FY 1989 report to the Advisory Council. The primary objective of the project is to collect hydrologic and water-quality information that will help identify source areas for saline discharge and result in improved estimates of salt loading from public lands.

To achieve this objective, four gauging stations were established. The stations are located in the Muddy River, Meadow Valley Wash, Pahranagat Wash, and Las Vegas Wash basins above major urban and agricultural developments. Streamflow and specific-conductance data are collected daily, and water-quality samples are collected monthly, with supplemental sampling during storm runoff. Laboratory analyses include dissolved solids and concentrations of major water quality constituents. These data, in conjunction with data from existing monitoring stations at the mouths of the major rivers, will provide the information needed to estimate the magnitude of salt contribution from public lands, thus forming a basis for the development of rational salinity-control plans. A report tabulating the data collected at the four gauging stations from October 1988 through September 1991 is complete but unpublished at this time. Data are also published annually in the USGS Water Data Report for Nevada.

After September of this year (1993), a report describing estimated water and salt budgets will be prepared for the basins. Data from the stations mentioned previously and reconnaissance samples from ephemeral streams, springs, and wells in the basins will be used in preparing the report. The five-year budgets will include an estimate of contributions of salt from the respective drainage basins to the surface waters. Regional correlation techniques will be used to extend the five-year budgets to long-term estimates.

New Mexico

In addition to the activities related to the hydrologic data program (attachment 1), the New Mexico District was involved with three interpretative studies during fiscal year 1993.

Reconnaissance and Detailed Investigations of Irrigation Drainage in the San Juan River Area, San Juan County, Northwestern New Mexico

A reconnaissance investigation, which was a cooperative study by the U.S. Geological Survey, Fish and Wildlife Service, Bureau of Indian Affairs, and the Bureau of Reclamation, was completed when the final report received Director's approval. The objectives of the study were:

a. to determine the concentrations of major ions, trace elements, and selected pesticides in water, sediment, and biota in the San Juan River area, and

b. to assess the degree that irrigation drainage contributes to these concentrations.

The final report, "Reconnaissance investigation of water-quality, bottom sediment, and biota associated with irrigation drainage in the San Juan River area, San Juan County, northwestern New Mexico, 1990-91" by Paul J. Blanchard and others, is being released as Water Resources Investigations Report 93-4065.

Based on findings of the reconnaissance investigation, a detailed study of selected irrigation projects in the San Juan River area was begun in fiscal year 1993. The study involves the same agencies as previously. The overall objectives of the detailed study are to:

a. determine the sources, distribution, movement, and fate of selenium and other contaminants within the San Juan River area, and

b. measure contaminant concentrations, determine exposure pathways, and document the effects of the contaminants on biota. Field work began in the spring of 1993.

Reconnaissance Study of the Water Quality of the San Juan and Chaco Rivers and Selected Aquifers from Near Farmington to Below Shiprock, New Mexico

This study was a cooperative effort by the U.S. Geological Survey and the Bureau of Reclamation. Water-quality data were collected to evaluate the potential contribution to increased salinity in the San Juan and Chaco Rivers from natural ground-water discharge and from oil and gas well installations. The final report has been published: "Water-quality data from the San Juan and Chaco Rivers and selected alluvial aquifers, San Juan County, New Mexico" by Conde R. Thorn, Open-File Report 93-84.

Utah

This study investigates the elevated and possibly increasing salinity in the water of the Navajo and other sandstone aquifers in the Aneth area, San Juan County, Utah. Over the last 25 years, specific-conductance measurements of water from selected wells tapping the Navajo and Entrada Sandstones apparently have increased. A field investigation conducted in fiscal year 1989 confirmed salinity increases on the order of 2,000 mg/L in selected wells. Water wells with the largest dissolved-solids concentrations are within or adjacent to the perimeter of the Greater Aneth and Ismay-Flodine Park petroleum fields.

Specific objectives are: (1) to identify conservative and nonconservative inorganic, isotopic, and non-volatile organic and geochemical constituents that can be used to define the source(s) and path(s) of the saline water invasion of freshwater aquifers; (2) to utilize geophysical techniques to determine the area and volume of aquifer invaded by the saline water; and (3) to utilize the geochemical data from objective (1) and the newly developed chemometrics software PIROUETTE to identify, classify, and quantify source solutions throughout the intruded freshwater aquifer.

Data collection continued during fiscal year 93 and included sampling additional wells completed in the Navajo aquifer, as well as injection brines and the San Juan River. Six samples of dissolved organic matter were extracted from ground-water samples using a reverse osmosis unit. Redox information including ferrous iron, sulfide, and dissolved oxygen concentrations along with Eh were collected at over 30 sites in the study area. Pressure heads and water levels were collected from wells throughout the study area.

Pyrolysis mass spectrums from selected ground-water samples were obtained over a range of 40 to 450 daltons. Comparison of the mass spectrums indicated distinctly different fingerprints between oil field samples and water from the Navajo aquifer. These techniques appear promising for field work planned in fiscal year 94. An isotopic mixing model simulating the secondary recovery injection processes was constructed using the mixing relationship between the injected brines and water from the San Juan River. Salt norms were calculated from the existing data, and pattern recognition modeling techniques were utilized to distinguish between different sources contributing salinity to the Navajo aquifer in the study area. A paper describing the preliminary bromide/chloride and isotopic mixing models was presented at an American Association of Petroleum Geologists conference during September 1993. Inorganic data-collection activities and a reconnaissance surface geophysical survey will conclude in early fiscal year 94. Data interpretation, report preparation, and organic geochemical sampling will continue during fiscal year 94.

Irrigation Drainage and Selenium--Middle Green River Basin

Detailed study of wildlife areas in the Middle Green River Basin of Utah during 1986-90 has shown that concentrations of selenium in water and biological tissues were harmful to wildlife at the Stewart Lake Waterfowl Management Area, lower Ashley Creek, and the Ouray National Wildlife Refuge. The sources of the Ashley Creek contaminatioin were springs and seeps that discharged water containing as much as 15,000 µg/L of selenium. Selenium concentrations in irrigation drainage entering Stewart Lake ranged from 14 to 140 µg/L; liver tissues from coots collected from the lake contained as much as 26 µg/g; and samples of carp contained as much as 31 µg/g. The sources of selenium at Stewart Lake are irrigation drainage and shallow groundwater flowing through sedimentary deposits of marine and nonmarine origin.

A significant linear relation, (R^2=0.65), exists between concentrations of dissolved selenium discharging to Ashley Creek and concentrations of dissolved solids, but no relation (R^2=<0.01) exists between loads of selenium and loads of dissolved solids. This indicates that salinity controls that are chosen only to treat large sources of salt loading may fail to control loads of selenium.

The largest source of selenium contamination in the area is seepage originating from the Vernal sewage lagoons. Water in the lagoons is free of selenium, but water passes through fractured Mancos shale and discharges to Ashley Creek carrying a selenium load in excess of one kilogram per day. There is no direct involvement of a DOI project associated with the sewage lagoons, so planning for remediation will address only the 5-10 percent of the total selenium load contributed by the Vernal Unit of the Central Utah Project, a DOI project.

In FY 1991, the Bureau of Reclamation, with input from USGS and U.S. Fish and Wildlife Service (FWS), began planning remedial action at the contaminated sites. A series of public scoping meetings were held in 1992-93 to solicit public comment on selenium contamination in the area. Options for remediation of contamination at Stewart Lake were developed and are being evaluated for acceptability, cost, and effectiveness. Planning for remediation should be completed by 1995. USGS and FWS will continue to monitor the areas until a remedial plan is selected and through implementation.

Uinta Basin Ground-Water Salinity Monitoring

In 1993, the U.S. Geological Survey, Water Resources Division, collected water samples from ten water wells and five injection wells in the Uinta Basin in cooperation with the Utah Division of Oil, Gas, and Mining. The water well samples were analyzed for constituents typically associated with oil-field brines in an effort to detect early any movement of saline water related to injection of oil-field brines as a method of disposal into the aquifers used for water supply in the area. Injected brines were sampled and analyzed to identify the character of these possible end members of the hydrochemical system. Constituents analyzed included common ions; total dissolved solids; iodide; iron; boron; bromide; total organic carbon; and isotopes of hydrogen, oxygen, and sulfur.

Attachment 1.–Hydrologic Data Program Activities Colorado River Basin, 1993

State	Number of active stations		Number of stations discontinued as of 10/01/93		Agencies involved in the Program
	Stream flow	Water Quality	Stream flow	Water Quality	
Arizona	222	34	5	2	Increases and Decreases: ADEQ, ADWR, NHIRC
Colorado	180*	62	12	0	Increases and Decreases: local cooperators
Nevada	22	19	15	16	Increases: local cooperators
New Mexico	8	6	0	0	No change
Utah	87	14	7	2	Increases: OFA,local cooperators Decreases: local cooperators
Wyoming	21	18	3	1	Decreases: State cooperator
Total	540	153	42	21	

*Streamflow stations include those operated and maintained by the State Engineer's Office.

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Bureau of Land Management
Colorado River Basin Salinity Control Program
Accomplishments for fiscal year 1993

In **Arizona**, BLM continued a soils inventory with special consideration for identification of saline soils. One hundred and fifty thousand acres were completed in central Mohave County. Reconnaissance planning continued in Bulrush Draw and Hurricane Wash. Repairs were completed on the Warren Dikes of the Clayhole Allotment, reducing runoff and salt yield into the Virgin River. Monitoring continued of water quality, sedimentation, and total dissolved solids in Aravaipa Creek and on the San Simon and San Pedro Rivers.

Total Salinity Dollars Spent = $20,000

In **Colorado**, implementation of salinity control activities is underway at Milk/Alkali and Baking Powder Basins. Maintenance of salinity control projects and roads was performed at Lower Wolf Creek, Grand Valley, and the Milk/Alkali drainage. Monitoring is underway on Lower Wolf, Elephant Skin Wash, Milk/Alkali, Horse Creek, Willow Creek, and Poison Creek. Bureau of Reclamation and BLM are working under Interagency Agreement to implement measures which will decrease soil erosion and salt loading in the Grand Valley salt desert area. Monitoring will be conducted on improved rangeland practices in relation to increasing vegetative cover.

Total Salinity Dollars Spent = $330,000

In **New Mexico**, BLM has continued earlier efforts in the San Juan Basin to control salts. Implementation of the roads policy has led to substantial industry investment in road upgrade, design, and maintenance. BLM has continued to work with the State of New Mexico to acquire funds for plugging orphaned wells, and has also cooperated on the unlined pit closure/remediation efforts in the expanded "San Juan vulnerable area," as defined by the New Mexico Oil Conservation District. The interagency investigation of the hydrology and salinity of the Anetha Project Area continued for a third year.

A new full-time position in the Farmington District Office will support efforts in the newly implemented Pump Canyon demonstration project, through which best management practices (riparian, grazing, oil, and gas rehabilitation) will be demonstrated and monitored. A water monitoring system has been completed this year to trace salinity and water quality impacts which may be attributable to oil and gas activities. This system is scheduled for FY 1994 implementation.

Total Salinity Dollars Spent: $45,000

In **Nevada**, a five year study by Water Resources Division, USGS, has been completed for BLM on the Las Vegas, Meadow Valley, and Pahranagat Washes and Muddy River. A preliminary report describing salinity sources concentration and flows has been provided for BLM review.

Total Salinity Dollars Spent = $20,000

In **Utah**, BLM has been conducting 2,000 acres of riparian area and condition inventory for segments of the Virgin River, Cedar City District. The soil map for the Grand Resource Area has been readied for use on the GIS System.

The comprehensive planning effort for the Sagers Wash area was completed in February of 1993. In the Vernal District's portion of the Red Creek Basin, comprehensive planning is underway. Reconnaissance planning has been conducted for the Willow Springs and Saleratus Benches areas, and SCS is preparing the final reports.

The Castle Peak salinity control unit is concluding its third and final year of project implementation. All proposed monitoring equipment is now installed and data collection and analysis have begun. Watershed implementation of 30 erosion and salinity control structures has been done in Moab, Vernal, and Richfield Districts, as well as some riparian area fencing.

BLM is monitoring at three locations in Sagers Wash for precipitation and associated runoff, sediment, and salt yield. A Remote Automated Weather Station (RAWS) platform with a salinity probe has been installed on Pariette Wash. Monitoring of 82 watershed sites is continuing.

Total Salinity Dollars Spent = $104,000

In **Wyoming**, BLM continued the monitoring of watershed function and water quality changes associated with earlier salinity control work in the Muddy Creek watershed. A network of eight water quality stations was maintained and operated to quantify the effects of improved management and treatments on salt transport. In addition, an aging waterspreader project was stabilized to ensure that the 30 year of sediment and salt accumulation was not released to the Colorado River system.

In the Red Creek drainage, materials have been purchased in preparation for the protection of eroding stream channels and the maintenance of stream structures. A stream gauging/water quality station was also installed to monitor water quality improvement associated with the implementation of the Red Creek Management Plan. Preliminary project planning work was completed for the maintenance of a detention reservoir and the implementation of a contour brush crushing treatment designed to improve watershed condition and reduce overload flow and erosion.

A cooperative Phase I watershed ranking effort has been completed with BLM assistance. High priority watersheds for reconnaissance, comprehensive planning and implementation were identified.

Total Salinity Dollars Spent = $85,000

BLM Assessment of Funding Needs
Colorado River Basin Salinity Control Program

(dollars in thousands)

Activity	**Fiscal Year 1994**
Inventory	$1,410
Reconnaissance Planning	220
Comprehensive Planning	250
Implementation	2,950
Maintenance	300
Monitoring	250
Support	90
Total	**$5,470**

Bureau of Reclamation
Colorado River Basin Salinity Control Program
Accomplishments for fiscal year 1993

Planning Activities

Big Sandy River Unit, Wyoming

Reclamation's planning activities for this unit will be finished after one deep aquifer monitoring well is plugged. Because the monitoring well is on BLM lands, Reclamation and BLM have signed a cooperative agreement for BLM to oversee the plugging of the well. At the direction of the BLM, geophysics testing is scheduled for completion in the fall of 1993. If appropriate, the well will be plugged with grout early in 1994.

Colorado River Simulation System Support

Colorado River Simulation System (CRSS) is used extensively by Reclamation to forecast salinity conditions and evaluate compliance with the water quality (salinity) standards. To do this, accurate water use data is needed as a base for these predictions. Preparing base maps for a remote sensing program to refine current water use estimates in the upper Colorado River Basin are among the activities that support CRSS.

Lower Gunnison Basin Unit, Colorado

Reclamation completed a study evaluating alternatives to reduce the cost of the canal and lateral lining. The study found construction costs could be significantly reduced by eliminating the canal lining program, by combining and piping the laterals, and by the continued use of construction cooperative agreements with the water districts. Reclamation has been working on a preconstruction report.

Glenwood-Dotsero Springs Unit, Colorado

Under a cooperative agreement with Reclamation, private developers are investigating the feasibility of privatizing salinity control of the saline springs around Glenwood Springs, Colorado. In 1993, the project sponsors developed a more locally acceptable desalination alternative.

Non-point Source Control, Utah.

Reclamation began working in cooperation with the BLM to evaluate the effectiveness of various rangeland management techniques for erosion and salinity control as an outcome of the Non-point Source Control Screening Studies in Utah and Colorado. In 1993, the monitoring program was up and fully operational in the Castle Peak and Sagers Wash study areas.

North Desert Study

In Colorado, Reclamation and BLM have scoped plans to jointly evaluate the effectiveness of grazing management to improve soil and salinity conditions in the Grand Junction area. In 1993, a cooperative agreement for the study was drafted and monitoring plans developed to use each agency's expertise.

Price-San Rafael Rivers Unit, Utah

The USDA and Reclamation prepared a combined Reclamation/SCS draft PR/EIS evaluating a comprehensive salinity control program for agriculture in these two basins. During 1993, Reclamation developed responses to the draft PR/EIS and worked to resolve USDA wetland replacement issues raised during this review. The final report is being revised to reflect new salinity benefit estimates and should be complete early in 1994.

San Juan River Unit, New Mexico

Reclamation is nearing completion of a draft planning report which evaluates alternatives to control salinity on the Hammond Project. The report recommends canal lining as a cost effective way to control seepage and salinity. Wildlife habitat replacement plans are the only remaining issue to be resolved.

Investigations of the Hogback Project were initiated in 1993 with canal seepage testing. Reclamation is also participating in a study with the USGS and others to investigate the Aneth Oil Field and to identify sources of salinity in that area.

Surge Irrigation Demonstration, Utah and Colorado

Reclamation and agencies of the USDA developed a program to demonstrate efficient irrigation technologies to farmers as part of the salinity control program. Due to its outstanding success in the Grand Valley, Reclamation has moved its program into two new areas. In 1992 the program was expanded into the Lower Gunnison Basin, Colorado and in 1993, into the Price and San Rafael Basins in Utah.

Construction

Dolores/McElmo Creek Unit, Colorado

Reach 1 and 2 of the Towaoc Canal have been completed. Work is now underway to complete the Rocky Ford Laterals, which deliver water from the Towaoc Canal. Contracts for lining three sections of the Lone Pine Lateral and the one section of the Upper Hermana Lateral have been awarded and are under construction. The unit is scheduled to be completed in 1994.

Grand Valley Unit, Colorado

Construction is underway on parts of the east end of the Government Highline Canal as well as the Price and Stubb Ditch systems. Reach 1b of the Government Highline Canal is under construction. Reach 1a will be awarded in fiscal year 94.

Work on the Mesa County Irrigation District and Palisades Irrigation District construction cooperative agreements for the Price and Stubb Ditch system improvements is about 40 percent complete with 29 of 70 miles of canal and lateral work completed. Work on these systems is expected to be completed in about 3 years. The Grand Valley Water Users have completed 11 of 60 miles of laterals. This cooperative agreement is scheduled to be completed in the next 4 to 5 years.

Lower Gunnison Basin Unit, Colorado

Winter water replacement system is about 80 percent complete with $14 million having been spent through fiscal year 1993. A total of 120 miles out of 140 miles of pipe have been laid through 1993. Only 20 miles remain to be installed in 1994. About $4 million of work remains to complete the winter water system. Most of the remaining work is being done by the Chipeta Water Company. They should be done by September 1994.

Paradox Valley Unit, Colorado

Reclamation's testing program at Paradox is designed to evaluate the feasibility of deep well injection as a method of brine (salt) disposal. The testing program is addressing three issues:

- Mechanical and operational costs.
- Chemical incompatibility.
- Injectivity of the receiving formation.

In 1993, Reclamation completed repairs identified in its shakedown testing of the facility in 1992, including mechanical and electrical upgrades, acid stimulation of the well, injection of a freshwater buffer zone, and initial pump-in testing with brine.

Experience in operating the well has defined the costs. If the well can accept enough brine, the operation will be cost effective. Cost effectiveness is driven by costs and tons removed. The critical issue remaining to be resolved is the injectivity of the well. The costs are fairly well known, but without an estimate of how much brine (salt) can be injected, the cost effectiveness cannot be computed.

If testing of the receiving formation shows that the well can accept sufficient amounts of brine to be cost effective, a planning report will be prepared to evaluate alternatives and determine if the injection facility should be expanded to include pretreatment of the brine for sulfate removal or abandoned. Sulfate removal would eliminate chemical incompatibility problem.

Chemical incompatibility of the brine with the receiving formation was tested and confirmed by independent consultants. Sulfate removal, a relatively simple process, should be sufficient to eliminate this problem. This will be pursued only if injection testing demonstrates that the well will be reasonably cost effective.

If at any time during testing of the receiving formation, the test results show that well cannot accept sufficient amounts of brine to be cost effective, a planning report would be prepared to evaluate other alternatives for the unit, (e.g., evaporation).

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COACHELLA VALLEY WATER DISTRICT

ENGINEER'S REPORT
ON
WATER SUPPLY AND
REPLENISHMENT ASSESSMENT
1988/1989

Prepared by
Water Resources Division
Engineering Department
April 1988

COACHELLA VALLEY WATER DISTRICT

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Warren A. Norried, Jr.	Water Resources Engineer
Alan Harrell	Engineering Technician

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I. INTRODUCTION

The Coachella Valley Water District (District) serves an area of approximately 1,000 square miles in the Coachella Valley within the Counties of Riverside, Imperial and San Diego. The Coachella Valley is located in the northwesterly portion of the arid Colorado Desert of California. High mountains border the Valley to the west and north and provide an effective barrier against coastal storms; therefore, direct precipitation does not contribute significantly to the water supply on the Valley floor. The groundwater basin is recharged by runoff from the adjacent mountains.

The need for supplemental water has been recognized in the Valley for many years. The formation of the District in 1918 was a direct result of the concern of the residents over a plan to export water from the Whitewater River to Imperial Valley. The early residents of the Valley recognized that action must be taken to reduce the lowering of the water table which was occurring as a result of their pumpage and entered into agreements for the construction of the Coachella Branch of the All-American Canal. Since 1949 the Coachella Canal has been providing water for irrigation use in an area generally from Indio and La Quinta south to the Salton Sea.

After resolution of the water supply problem in the lower Valley and the start of recreational development in the upper Valley, the need for supplemental water in the upper Valley was recognized. As a result, the District and Desert Water Agency (DWA) entered into separate contracts to ensure that water from the State Water Project would be available for the upper Valley. The Coachella Aqueduct which will bring Northern California water into the Valley has not been constructed. Therefore, DWA and the District entered into an agreement with Metropolitan Water District of Southern California (MWD) to obtain water from the MWD aqueduct which crosses the upper portion of the Coachella Valley near Whitewater, in exchange for the two agencies' water from the State Water Project. Since 1973 water from this source has been used for groundwater recharge.

In addition, the District, recognizing the need for additional water, entered the water reclamation field and currently operates six facilities in the Valley. Effluent from two of these facilities has been used for golf course and greenbelt irrigation, thereby reducing demand on the groundwater basin.

The District and DWA, recognizing that management of the upper Valley groundwater basin extended across agency boundaries, entered into a management agreement for the upper Valley in 1976. This agreement recognized the need to operate the groundwater basin as a complete unit rather than as individual segments underlying the individual agency boundaries.

The District is authorized by law to levy a replenishment assessment to pay for certain costs associated with obtaining supplemental water for replenishment of the water supply within the District.

II. GROUNDWATER BASIN DESCRIPTIONS

A. GEOLOGY

The Coachella Valley Groundwater Basin as described by the Department of Water Resources (DWR), is bounded on the easterly side by the non-water-bearing crystalline rocks of the San Bernardino and Little San Bernardino Mountains and on the westerly side by the crystalline rocks of the Santa Rosa and San Jacinto Mountains. The trace of the Banning Fault on the north side of San Gorgonio Pass forms the upper boundary.

The lower boundary is formed primarily by the watershed of the Mecca Hills and by the northwest shoreline of the Salton Sea running between the Santa Rosa Mountains and Mortmar. Between the Salton Sea and Travertine Rock, at the base of the Santa Rosa Mountains, the lower boundary coincides with the Riverside-Imperial County Line.

Southerly of the lower boundary, at Mortmar and at Travertine Rock, the subsurface materials are predominantly fine-grained and low in permeability; although groundwater is present, it is not readily extractable. A zone of transition exists at these boundaries, and to the north the subsurface materials are coarser and yield water readily.

Although there is interflow of groundwater throughout the groundwater basin, fault barriers, constrictions in the basin profile, and areas of low permeability limit and control movement of groundwater. Based on these factors, the groundwater basin has been divided into subbasins and subareas as described by DWR and the United States Geological Survey (USGS).

The subbasins are Mission Creek, Garnet Hill, Whitewater River (Indio) and Desert Hot Springs Subbasins. The subbasins, with their groundwater storage reservoirs, are defined without regard to water quantity or quality. They delineate areas underlain by formations which readily yield stored water through water wells, and offer natural reservoirs for the regulation of water supplies.

The boundaries between subbasins within the groundwater basin are generally based upon faults that are effective barriers to the lateral movement of groundwater. Minor subareas have also been delineated, based on one or more of the following geologic or hydrologic characteristics: type of water-bearing formations, water quality, areas of confined groundwater, forebay areas, groundwater divides and surface divides.

Following is a list of the subbasins based on the United States Geological Survey designations:

Whitewater River Subbasin

- Palm Springs Subarea
- Thermal Subarea
- Thousand Palms Subarea
- Oasis Subarea

Mission Creek Subbasin

Garnet Hill Subbasin

Desert Hot Springs Subbasin

Figure 1 (Appendix A) shows the subbasins.

The following are areas within the Coachella Valley where a supply of potable groundwater is not readily available:

Indio Hills Area

Mecca Hills Area

Barton Canyon Area

Bombay Beach Area

Salton City Area

B. MISSION CREEK SUBBASIN

Water-bearing materials underlying the Mission Creek upland comprise the Mission Creek Subbasin. The subbasin is bounded on the south by the Banning Fault and on the north and east by the Mission Creek Fault. It is bordered on the west by non-water-bearing rocks of the San Bernardino Mountains. To the southeast of the subbasin are the Indio Hills. The area within this boundary reflects the estimated limit of effective storage within the subbasin.

Both the Mission Creek Fault and the Banning Fault are effective barriers to groundwater movement, as evidenced by offset water levels, fault springs, and changes in vegetation. Water level measurements in the Spring of 1961 between Wells 03S05E04L02S and 03S05E04M01S indicated a vertical difference in the groundwater table elevation of 255 feet in a horizontal distance of 1,600 feet across the Mission Creek Fault. Similar measurements of Wells 03S04E13H01S and 03S04E13N01S on either side of the Banning Fault indicated a vertical difference of 250 feet in water elevation over a horizontal distance of 4,900 feet. Water levels are higher on the north side of both faults.

All known wells in the subbasin were drilled in Recent sands and gravels. At depths ranging from 20 to 170 feet, the wells pass through unconsolidated Recent material and encounter semi-consolidated and interbedded sands, gravels and silts similar to exposures of the Ocotillo conglomerate in the Indio Hills or the Cabazon fanglomerate exposed at Whitewater Hill. Although these Pleistocene deposits are the main source of water, water also occurs in Recent alluvium where the water table is sufficiently shallow.

Water levels in the Mission Creek Subbasin were determined in the 1971 USGS investigation. Measured depths below ground surface of water in the subbasin range from a maximum of 425 feet in the northwestern portion to flowing wells, as a minimum, in a narrow strip along the Banning Fault northwest of Seven Palms Ridge. Although semi-confined groundwater is present, as indicated by the flowing wells, it is believed that the greater portion of the groundwater body is unconfined. Movement of water within the subbasin is generally southwest. However, in spite of the moderate to high permeability of the water-bearing materials, the flat gradient suggests the rate of movement is not great. Historic water levels indicate a general rise within the subbasin between 1938 and 1952. Since 1952, a steady water level decline of 0.5 to 1.5 feet per year has been observed.

Surface runoff and groundwater inflow from the Little San Bernardino Mountains and Indio Hills bring high concentrations of undesirable mineral constituents into the lower southerly portion of the Mission Creek Subbasin easterly from approximately Palm Drive in the City of Desert Hot Springs.

C. WHITEWATER RIVER SUBBASIN

The Whitewater River Subbasin, known also as the Indio Subbasin, comprises the major portion of the floor of the Coachella Valley and encompasses approximately 400 square miles. Beginning approximately one mile west of the junction of State Highway 111 and Interstate Highway 10, the Whitewater River Subbasin extends southeast approximately 70 miles to the Salton Sea. The subbasin is bordered on the southwest by the Santa Rosa and San Jacinto Mountains, and is separated from Garnet Hill, Mission Creek and Desert Hot Springs Subbasins to the north and east by the Garnet Hill and San Andreas Faults.

The limit of the Whitewater River Subbasin along the base of the San Jacinto Mountains and the northeast portion of the Santa Rosa Mountains coincides with the Coachella Valley Groundwater Basin boundary. The Whitewater River Subbasin in this vicinity includes only the Recent terraces and alluvial fans. The Garnet Hill Fault, which extends southeastward from the north side of San Gorgonio Pass to the Indio Hills, is an effective barrier to groundwater movement from the Garnet Hill Subbasin into the Whitewater River Subbasin. The San Andreas Fault, extending southeastward from the junction of the Mission Creek and Banning Faults in the Indio Hills and continuing out of the basin on the east flank of the Salton Sea, is also an effective barrier to groundwater movement.

The Whitewater River Subbasin is divided into four subareas: Palm Springs, Thermal, Thousand Palms, and Oasis Subareas. The Palm Springs Subarea is the forebay or main area of recharge to the subbasin, and the Thermal Subarea comprises the pressure area within the basin. The other two subareas are peripheral areas having unconfined groundwater conditions.

The historic fluctuations of water levels within the Whitewater River Subbasin indicate a steady decline in the levels throughout the subbasin prior to 1949. After 1949, levels in the lower Thermal Subarea (south of Point Happy), where imported Colorado River water is used for irrigation, rose sharply, although elsewhere in the subbasin water levels continued to decline.

With the use of Colorado River water from the Coachella Canal there has been less demand on the groundwater basin below Point Happy. Water levels in the deeper aquifers have risen since 1949, and should continue to rise or maintain equilibrium barring a great increase in groundwater use in that portion of the groundwater basin.

1. PALM SPRINGS SUBAREA

The triangular area between the Garnet Hill Fault and the east slope of the San Jacinto Mountains southeast to Cathedral City is designated the Palm Springs Subarea, and is an area in which unconfined groundwater occurs. The valley fill materials within the subarea are essentially heterogeneous alluvial fan deposits exhibiting little sorting and with little content of fine-grained material. Thickness of these water-bearing materials is not known; however, it exceeds 1,000 feet. Although no lithologic distinction is apparent from well drillers' logs, the probable thickness of Recent deposits suggests that Ocotillo conglomerate underlies Recent fanglomerate in the subarea at depths ranging from 300 to 400 feet.

Recharge of groundwater to the aquifers in the Whitewater River Subbasin occurs primarily in the Palm Springs Subarea. The major natural sources include infiltration of stream runoff from the San Jacinto Mountains and the Whitewater River, and subsurface inflow from the San Gorgonio Pass Subbasin. Deep percolation of direct precipitation on the Palm Springs Subarea is considered negligible.

Before the recharge program began, depth to water in the subarea ranged from 200 feet below the surface near Cathedral City to nearly 500 feet at the northwestern end of the subbasin near the spreading works downstream of Windy Point.

2. THERMAL SUBAREA

Groundwater of the Palm Springs Subarea moves southeastward into the interbedded sands, silts, and clays underlying the central portion of the Indio Plain. The division between the Palm Springs Subarea and the Thermal Subarea is near Cathedral City. The permeabilities parallel to the bedding of the deposits in the Thermal Subarea are several times the permeabilities normal to the bedding and, as a result, movement of groundwater parallel to the bedding predominates. Confined or semi-confined groundwater conditions are present in the major portion of the Thermal Subarea. Movement of water under these conditions is present in the major portion of the Thermal Subarea and is caused by differences in piezometric levels, or head. Unconfined or free water conditions are present in the alluvial fans at the base of the Santa Rosa Mountains, as in the fans at the mouth of Deep Canyon and in the La Quinta area.

Sand and gravel lenses underlying this subarea are discontinuous and clay beds are not extensive. However, two aquifer zones separated by a zone of finer-grained materials were identified from well logs. The fine-grained materials within the intervening horizontal plane are not tight enough or persistent enough to restrict completely the vertical interflow of water, or to assign the name aquiclude in reference to it. Therefore, the term aquitard is used for this zone of less permeable material which separates the upper and lower aquifer zones in the lower Valley. Capping the upper aquifer at the surface are tight clays and silts with minor amounts of sands. Semi-perched groundwater occurs in this capping zone, which is up to 100 feet thick.

The lower aquifer zone, composed of part of the Ocotillo conglomerate, consists of silty sands and gravels with interbeds of silt and clay. It is the most important source of groundwater in the Coachella Valley Groundwater Basin, but serves only the lower Valley. The top of the lower aquifer zone is present at a depth ranging from 300 to 600 feet below the surface. The thickness of the zone is undetermined, as the deepest wells present in the Valley have not penetrated it in its entirety. The available data indicate that the zone is at least 500 feet thick and may be in excess of 1,000 feet thick.

The aquitard overlying the lower aquifer zone is generally 100 to 200 feet thick, although in small areas on the periphery of the Salton Sea it is in excess of 500 feet in thickness. North and west of Indio, in an arcuate zone approximately one mile wide, the aquitard is apparently lacking and no distinction is made between upper and lower aquifer zones.

The upper aquifer zone in the Thermal Subarea is similar in lithology to the lower aquifer, although it is not as thick. Subsurface inflow to the upper zone is less than that to the lower aquifer zone. As the water levels in the Palm Springs Subarea continue to drop, the cross sectional area of the upper zone available for recharge at Point Happy is reduced.

Capping the upper aquifer zone in the Thermal Subarea is a shallow fine-grained zone in which semi-perched groundwater is present. This zone consists of Recent silts, clays, and fine sands and is relatively persistent southeast of Indio. It ranges from zero to 100 feet thick and is generally an effective barrier to deep percolation. However, north and west of Indio, the zone is composed mainly of clayey sands and silts and its effect in retarding deep percolation is limited. The low permeability of the materials southeast of Indio has contributed to the irrigation drainage problems of the area. Semi-perched groundwater has been maintained by irrigation water applied to agricultural lands south of Point Happy.

The Thermal Subarea contains the division between the upper and lower Whitewater River Subbasin groundwater tables. Primarily due to the application of imported water from the Coachella Canal, and an attendant reduction in groundwater pumpage, the water table in the area southerly from Point Happy has been rising, while the water table in the area northerly from Point Happy has been dropping. This division forms the lower (Southern) boundary of the Management Area of the DWA/District Management Agreement. Water table measurements have shown no distinction between the Palm Springs Subarea and the Thermal Subarea. The only distinction has been the hinge effect in the Thermal Subarea at Point Happy, where groundwater levels are stabilized, neither rising nor falling significantly (See Section C.1, Page 17).

3. THOUSAND PALMS SUBAREA

The small area along the southwest flank of the Indio Hills is named the Thousand Palms Subarea. The southwest boundary of the subarea was determined by tracing the limit of distinctive groundwater chemical characteristics. Whereas a calcium bicarbonate water is characteristic of the major aquifers of the Whitewater River Subbasin, water in the Thousand Palms Subarea is sodium sulfate in character.

The quality differences suggest that recharge to the Thousand Palms Subarea comes primarily from the Indio Hills and is limited in supply. The relatively sharp boundary between chemical characteristics of water derived from the Indio Hills and groundwater in the Thermal Subarea suggests there is little intermixing of the two.

The configuration of the water table north of the community of Thousand Palms is such that the generally uniform, southeast gradient in the Palm Springs Subarea diverges and steepens to the east along the base of Edom Hill. This steepened gradient suggests a barrier to the movement of groundwater, or a reduction in permeability of the water-bearing materials. A southeast extension of the Garnet Hill Fault would also coincide with this anomaly. However, there is no surface expression of such a fault, and the gravity measurements taken during the 1964 DWR investigation do not suggest a subsurface fault. The residual gravity profile across this area supports these observations. The sharp increase in gradient is therefore attributed to lower permeability of the materials to the east.

4. OASIS SUBAREA

Another peripheral zone of unconfined groundwater that is different in chemical characteristics from water in the major aquifers of the Whitewater River Subbasin is found underlying the Oasis Piedmont slope. This zone, named the Oasis Subarea, extends along the base of the Santa Rosa Mountains. Water-bearing materials underlying the subarea consist of highly permeable fan deposits. Although groundwater data suggest that the boundary between the Oasis and Thermal Subareas may be a buried fault extending from Travertine Rock to the community of Oasis, the remainder of the boundary is a lithologic change from the coarse fan deposits of the Oasis Subarea to the interbedded sands, gravel and silts of the Thermal Subarea. Little information is available as to the thickness of water-bearing materials, but it is estimated to be in excess of 1,000 feet.

D. GARNET HILL SUBBASIN

The area northeast of the Garnet Hill Fault and the Whitewater River Subbasin, named the Garnet Hill Subbasin, was separated as a distinct subbasin by the USGS because of the effectiveness of the Banning and Garnet Hill Faults as barriers to groundwater movement. This is illustrated by a difference of 170 feet in water level elevation in a horizontal distance of 3,200 feet across the Garnet Hill Fault, as measured in the Spring of 1961. The fault does not reach the surface and is probably effective as a barrier to groundwater movement only below a depth of 100 feet.

Although some recharge to the subbasin may come from Mission Creek and other streams which pass through during periods of high flood flows, the chemical character of the groundwater plus its direction of movement indicate that the main source of recharge to the subbasin comes from the Whitewater River through the permeable deposits which underlie Whitewater Hill.

E. DESERT HOT SPRINGS SUBBASIN

The coalescing alluvial fan deposits underlying the Dillon Road Piedmont Slope are the water-bearing materials of the Desert Hot Springs Subbasin.

The northeasterly boundary of the subbasin along the base of the Little San Bernardino Mountains from Little Morongo Canyon southeast to Thermal Canyon coincides with the northeasterly boundary of the groundwater basin. The southwest boundary of the subbasin is set by the Indio Hills, and the San Andreas and Mission Creek Faults.

The Mission Creek Fault forms the boundary from Little Morongo Canyon southeast to Pushawalla Canyon in the Indio Hills. Semi-water-bearing materials of the Indio Hills border the subbasin along the south boundary of Pushawalla Canyon, from the Mission Creek Fault east to the Indio Hills Fault. From Pushawalla Canyon to the southeast end of the Indio Hills, the boundary is defined by the Indio Hills Fault. The San Andreas Fault separates the Desert Hot Springs Subbasin from the Whitewater River Subbasin beneath the alluvial debris cone of Fargo and Thermal Canyons located between the Indio Hills and the Mecca Hills.

Between the Indio Hills Fault and the San Andreas Fault at the southeast end of the Indio Hills, the subbasin boundary is the contact between Recent alluvium and Plio-Pleistocene formations. The subbasin merges with the Mecca Hills to the southeast and the boundary is the southeastern side of Thermal Canyon from the San Andreas Fault to the Mecca Hills Fault. The boundary continues easterly along the southeast wall of a tributary wash to outcrops of crystalline basement rock of the Little San Bernardino Mountains near Interstate Highway 10.

The water-bearing materials in the subbasin are primarily coarse-grained and poorly sorted alluvial fan deposits, principally of the Ocotillo formation, but also including the overlying Recent deposits. In the vicinity of Thousand Palms Canyon, fine-grained interbeds are present in the Recent deposits. Although Recent fanglomerates cover most of the land surface, exposures of the Ocotillo conglomerate are present throughout the subbasin. Principal exposures occur at Miracle Hill, along the northeast flank of the Indio Hills, and near the southeast end of the subbasin. Recent alluvium in the subbasin ranges in thickness from a thin edge to over 100 feet. The thickness of the underlying Ocotillo conglomerate is estimated to be in excess of 700 feet. Well drillers' logs commonly describe the material as being cemented.

The area overlying the Desert Hot Springs Subbasin is not extensively developed except in the vicinity of the city of Desert Hot Springs. Hot water from springs along the northeast side of Mission Creek Fault supplies several hot-water spas in the area. However, the high, undesirable mineral content of the groundwater throughout the subbasin has limited its contribution to the overall agricultural water resources of the Valley.

III. WATER SUPPLY

A. COACHELLA VALLEY

In 1964 DWR estimated that the subbasins in the Coachella Valley Groundwater Basin contained, in the first 1,000 feet below the ground surface, approximately 39,200,000 acre-feet of water. For the capacities of the subbasins, see Table 1 (Appendix B).

Currently, only the Whitewater River Subbasin is developed to the point where any significant production occurs. The natural supply of water to the upper Valley is not keeping pace with the basin outflow due mainly to large consumptive uses created by the resort-recreation economy and permanent resident population. The imported Colorado River supply through the Coachella Canal is used solely for irrigation in the lower Valley. Annual deliveries of Colorado River water through the Coachella Canal of approximately 340,000 acre-feet are a significant component of the lower Valley hydrology.

Historical water level declines and conditions producing those declines have been extensively described by the USGS and DWR. The water surface elevations in the upper Valley are highest at the northwest end of each subbasin, illustrating that groundwater flow is from the northwest to the southeast in the Valley.

Although water levels have been declining throughout most of the subbasins since 1945, water levels in the lower Valley have risen because of imported water from the Coachella Canal and resulting decreased pumpage in that area.

Comparison of the 1936 water level and the 1973 water level shows that water levels declined more than 100 feet in parts of the Palm Springs Subarea and more than 70 feet in parts of the Palm Desert area during the 37-year period.

District Drawings 12A and 12B show the water level in the basin by years and are incorporated in the report by reference. Figures 2a, 2b, 3a and 3b (Appendix A) show representative examples of the water level in the basin by years. These drawings display data showing the declining water level in the upper Whitewater River Subbasin and the stabilized water level in the lower Whitewater River Subbasin. There has been a gradual lowering of the water table in the Mission Creek and Garnet Hill Subbasins and southerly Thermal/Oasis Subareas.

B. WATER REPLENISHMENT

Alleviation of the upper Whitewater River Subbasin overdraft was initiated by the District and DWA when the two agencies contracted with the State to purchase Northern California water from the State Water Project. The entitlements under the contracts for the two agencies are shown in Table 2 (Appendix B).

Since the facilities necessary to transport State Project water into the Valley have not been constructed, the two agencies entered into an agreement with MWD to exchange their entitlements to State Project water for Colorado River water from the MWD aqueduct which crosses the upper Valley.

The agreement allows for the exchange of like amounts of water in accordance with the two agencies' entitlements. The quantities of water delivered to date are shown in Table 3 (Appendix B). The effectiveness of the replenishment program has been demonstrated by increasing water levels in the immediate recharge area and by slowing water level declines in some upper Whitewater River Subbasin wells.

C. MANAGEMENT AREA

The District and DWA have recognized the need to manage the upper Whitewater River Subbasin as a complete unit rather than as individual segments underlying the individual agencies' boundaries. The Management Area consists of the Palm Springs and Thousand Palms Subareas and the portion of the Thermal Subarea experiencing a declining water table.

The Management Area was established to encompass the area of groundwater overdraft as evidenced by declining water table conditions, and includes portions of DWA and the District.

Groundwater production in the Management Area is defined as the extraction of groundwater by pumping or any other method within the boundaries of the area, or the diversion within the area of surface supplies which naturally replenish the groundwater supplies within the area and are used therein. Production within the Management Area is estimated to be as shown in Table 4 (Appendix B).

Based on long-term conditions, natural inflow into the Management Area is approximately 49,000 acre-feet per year and natural outflow from the same area is approximately 25,000 acre-feet per year.

1. SOUTHERN BOUNDARY

The southern boundary of the Management Area separates the upper Whitewater River Subbasin from the lower Whitewater River Subbasin and extends diagonally across the Valley from Point Happy northeast to the Indio Hills near Jefferson Street. This boundary was determined to be the extent of the area in which groundwater levels had ceased to decline significantly over the previous years. Approximately 60 wells are monitored annually to maintain surveillance over this boundary. Generally, the boundary separates the area of declining groundwater levels from the area where they have been sustained due to use of Coachella Canal water for irrigation.

2. CONSUMPTIVE USE

One of the most difficult water requirement parameters to quantify is the water which is consumed by animals and plants. It is generally estimated by identifying the quantity of water extracted from the basin and subtracting that quantity which is returned as non-consumptive use via septic tanks, leaching fields, percolation of water applied to plants, and other means. A simplified approach accepted by most hydrologists is to express the consumptive use as a percentage of total water production. In 1971, the USGS estimated consumptive use to be approximately 60 percent for the Valley. The data in Table 5 (Appendix B) were developed using this estimate.

3. OVERDRAFT

The Management Area's water supply is overdrawn and it will remain so even with the importation of water from outside the basin. Overdraft of the basin and its subbasins will continue with or without development; however, overdraft will increase with increased development. In effect, the groundwater subbasin is being mined since it will not be replenished sufficiently to recover fully.

Eventually, imported water may offset groundwater overdraft on an annual basis. With continued growth, it is anticipated that the per capita water production will decrease and some property will change from irrigated agricultural to residential with a saving in water consumption. Even so, water requirements are likely to continue to place demands on groundwater in storage.

A Groundwater Replenishment Program is needed to arrest or reduce declining water levels and to avoid any detrimental conditions that would occur.

D. <u>AREA OF BENEFIT</u>

A review of the groundwater subbasins which underlie the boundaries of the District indicates that only one area is being recharged with supplemental water. This area is the upper Whitewater River Subbasin.

Recharge occurs in the lower Whitewater River Subbasin as an indirect result of importation of Colorado River water via the Coachella Canal. The presence of confining aquitards prevents the percolation of the Colorado River water into the deeper aquifers. However, the water table in the deep aquifers (replenished by outflow from the southern boundary of the upper Whitewater River Subbasin near Point Happy) has risen with reduced groundwater pumpage due to Canal usage.

The other subbasins in the Coachella Valley (Mission Creek, Garnet Hill and Desert Hot Springs Subbasins) currently do not receive any supplemental water and therefore are excluded from further consideration.

The Area of Benefit for purposes of this report is shown on Figure 4 (Appendix A).

IV. REPLENISHMENT PROGRAM

The Replenishment Program currently in effect consists of obtaining supplemental water from the Colorado River Aqueduct of MWD in exchange for the DWA and District entitlements of State Project water, and recharging the groundwater basin within the Management Area. Supplemental water is obtained through a turnout from the MWD Aqueduct at Whitewater and follows the natural channel of the Whitewater River to spreading facilities located near Windy Point. Water entering the basin at this location results in groundwater recharge which benefits the entire upper Whitewater River Subbasin as described in the reports of the analytical work by the USGS (Tyley and Swain). Their work using analog and digital computer models of the upper Whitewater River Subbasin clearly demonstrates that recharge of supplemental water at Windy Point benefits the entire area. Figure 5 (Appendix A) shows Swain's projection of the impact of the recharging of supplemental water on the upper Whitewater River Subbasin as compared to no supplemental recharge. The water level in the year 2001 with supplemental recharge is approximately 30 to 40 feet higher in the Palm Desert area than without any supplemental recharge.

In 1984, MWD, DWA and District entered into an agreement during high flows on the Colorado River to allow for the advance delivery of Colorado River water to Coachella Valley. This replenished the basin more rapidly and allowed water, which otherwise would have been lost to the Gulf of California, to be captured and stored to meet future needs. It allowed MWD to bank about 600,000 acre-feet of water in our basin as a hedge against shortages along Southern California's coastal plain during drought. Until the banked water is needed, Coachella Valley well owners benefit by higher water tables and less pumping. When MWD needs the water, it will take both its Colorado River water and Coachella Valley's annual state project entitlements as long as necessary or until the banked allotment is exhausted. During the dry periods, when MWD is using both sources, DWA and District entitlements will be drawn from this previously delivered and stored water. This was done during part of 1987 and may be done in 1988, should the drought continue in Northern California. The two Coachella Valley agencies pay the State the costs of the water delivered to MWD in exchange for the transfer of the banked water.

V. REPLENISHMENT ASSESSMENT

A. STATE WATER CODE

Sections 31630 through 31639 of the State Water Code authorize the District to levy and collect water replenishment assessments for the purpose of replenishing groundwater supplies within the District. The Code defines production, producer, and minimal pumper for replenishment purposes as follows:

> "Production" or "produce" means the extraction of ground water by pumping or any other method within the boundaries of the district or the diversion within the district of surface supplies which naturally replenish the ground water supplies within the district and are used therein.
>
> "Producer" means any individual, partnership, association or group of individuals, lessee, firm, private corporation, or any public agency or public corporation, including, but not limited to, the Coachella Valley Water District.
>
> "Minimal pumper" means any producer who produces 25 or fewer acre-feet in any year.

The replenishment assessment is based on production within the upper Whitewater River Subbasin within the boundaries of the District and is limited to the Area of Benefit.

Production by minimal pumpers is exempt from assessment. There are approximately 40 to 50 minimal pumpers in the Area of Benefit. These producers were determined to be minimal pumpers by a thorough field investigation of the use of the wells. These are predominantly small wells serving rural acreages for both domestic and limited irrigation purposes. Maximum pumpage by the minimal pumpers in the Area of Benefit would be less than 1,250 acre-feet per year, or less than two percent of total annual production.

The Code defines replenishment assessment and it states that assessments may be levied upon all water production within the Area of Benefit provided the assessment charge is uniform throughout said Area of Benefit. The replenishment assessment charge is a monetary charge authorized by the State Water Code and uniformly applied to extractions of groundwater within certain specified geographic boundaries of the District for payments of an imported water supply purchased to supplement naturally existing water supplies. Charges for said supply are reimbursable to the State by the District and shall not exceed the sum of the Variable Operation, Maintenance, Power, and Replacement components of the Transportation Charges and the Delta Water Charges applicable at the time of the levy under the contracts between the District and the State of California and Desert Water Agency and the State of California for an imported water supply from the State Water Resources Development System. The assessment charge may also include any payments to DWA for similar payments by DWA to the State. The replenishment assessment charge considered herein is based on the most recent and most reliable information available with respect to applicable costs or charges and assessable water production.

The District has additional costs associated with the Replenishment Program which include operating the spreading facilities, continuing engineering studies, and well meter installation and maintenance. These costs however, are not included in determining the replenishment assessment charge.

B. STATE WATER PROJECT COSTS

The State Water Project (SWP) costs are based on the fiscal year. Calculation of the replenishment assessment charge may be found in Table 7 (Appendix B).

The allowable replenishment assessment charge shown in Table 7 is based on those charges reimbursable to DWR for SWP facilities which are necessary either for the conservation and development of a project water supply (Delta Water Charge), or for the conveyance of such supply to SWP service areas (Transportation Charge). In turn the District is reimbursed for these charges by levying a replenishment assessment upon water producers benefitting from the Water Replenishment Program. The amount of the replenishment assessment cannot exceed the Variable Operation, Maintenance, Power, and Replacement Components of the Transportation Charge, and the Delta Water Charge applicable at the time of the levy under the contract between the District and the State for an imported water supply from the State Water Resources Development System.

The Delta Water Charge is a charge for the construction of SWP conservation facilities such as Oroville Dam and Lake, Frenchman Dam and Lake, Antelope Dam and Lake, Delta facilities, and other additional conservation facilities throughout the State, including Southern California.

The Transportation Charge is a charge for use of the SWP facilities to transport and deliver water from Northern California to the vicinity of each contractor's turnout. Such facilities include portions of the California Aqueduct and various pipelines, lakes and power facilities.

Another significant cost included within the allowable Transportation Charge shown in Table 7 is SWP power requirements. Each year, the DWR develops short and long range aqueduct operation studies. These studies are needed to project the amount of electrical capacity and energy required to deliver the contractors' requested entitlement water in future years.

The estimated power load requirements for SWP can vary significantly, depending on the actual balance of water supply and water demand in a given year, and these load requirements primarily depend on annual statewide hydrologic conditions. The aqueduct operation studies used in developing projected SWP power are based on median year hydrologic conditions. Pumping an acre-foot of SWP water to Southern California requires approximately 4500 kilowatt hours of electrical energy at an estimated cost of approximately $90. The energy costs have increased significantly since the start of SWP deliveries because low cost power contracts have ended and energy must be obtained by developing new facilities or purchased in the open market. As we all are aware, energy costs have consistently outpaced the cost of living indexes over the past years.

C. ASSESSED PRODUCTION

Producers within the District are listed in Table 8 (Appendix B) together with their estimated fiscal year production and their total estimated fiscal year replenishment assessment. The amount of fiscal year production has been assumed to be equal to that which was produced in the preceding calendar year. The replenishment charge per acre-foot is based on the calculations in Table 7 (Appendix B).

VI. CONCLUSION AND RECOMMENDATION

Information on the present condition of the groundwater supply within the District indicates that there are five groundwater areas in an overdraft condition. These areas are the upper Coachella Valley's Mission Creek, upper Whitewater River, Garnet Hill, and Desert Hot Springs Subbasins and localized portions of the lower Whitewater River Subbasin. However, only one of these areas, the upper Whitewater River Subbasin, is being recharged with supplemental water and therefore, subject under the law to a replenishment assessment.

Because the average natural water inflow into the upper Whitewater River Subbasin is less than the production, the Replenishment Program, using supplemental water, must be continued.

Therefore, it is recommended that the Replenishment Assessment Charge determined in Table 7 (Appendix B) be levied upon all producers within the Area of Benefit in accordance with the State Water Code.

VII. BIBLIOGRAPHY

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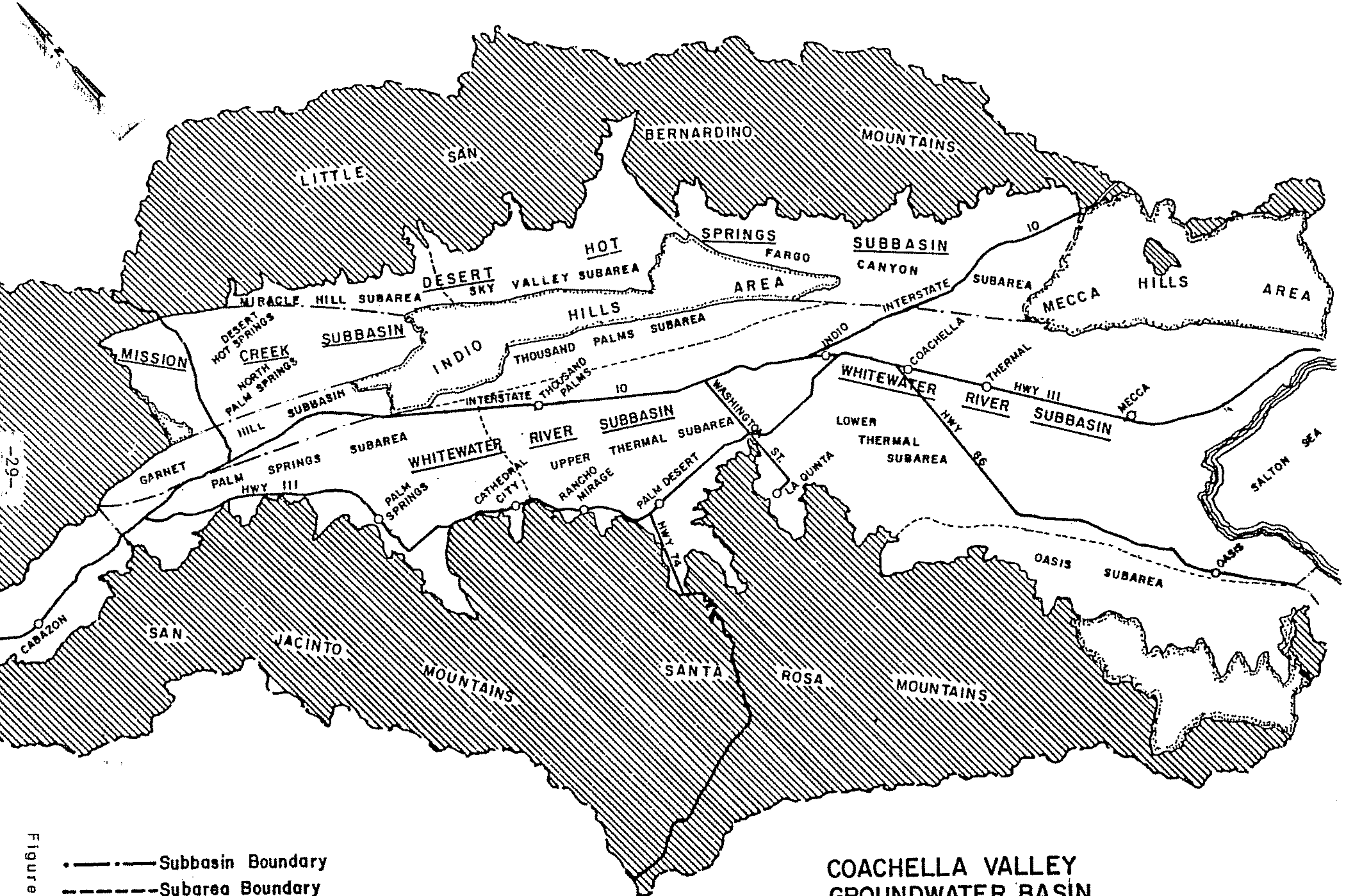
APPENDIX A
FIGURES



COACHELLA VALLEY
GROUNDWATER BASIN
SUBDIVISIONS

Figure 1

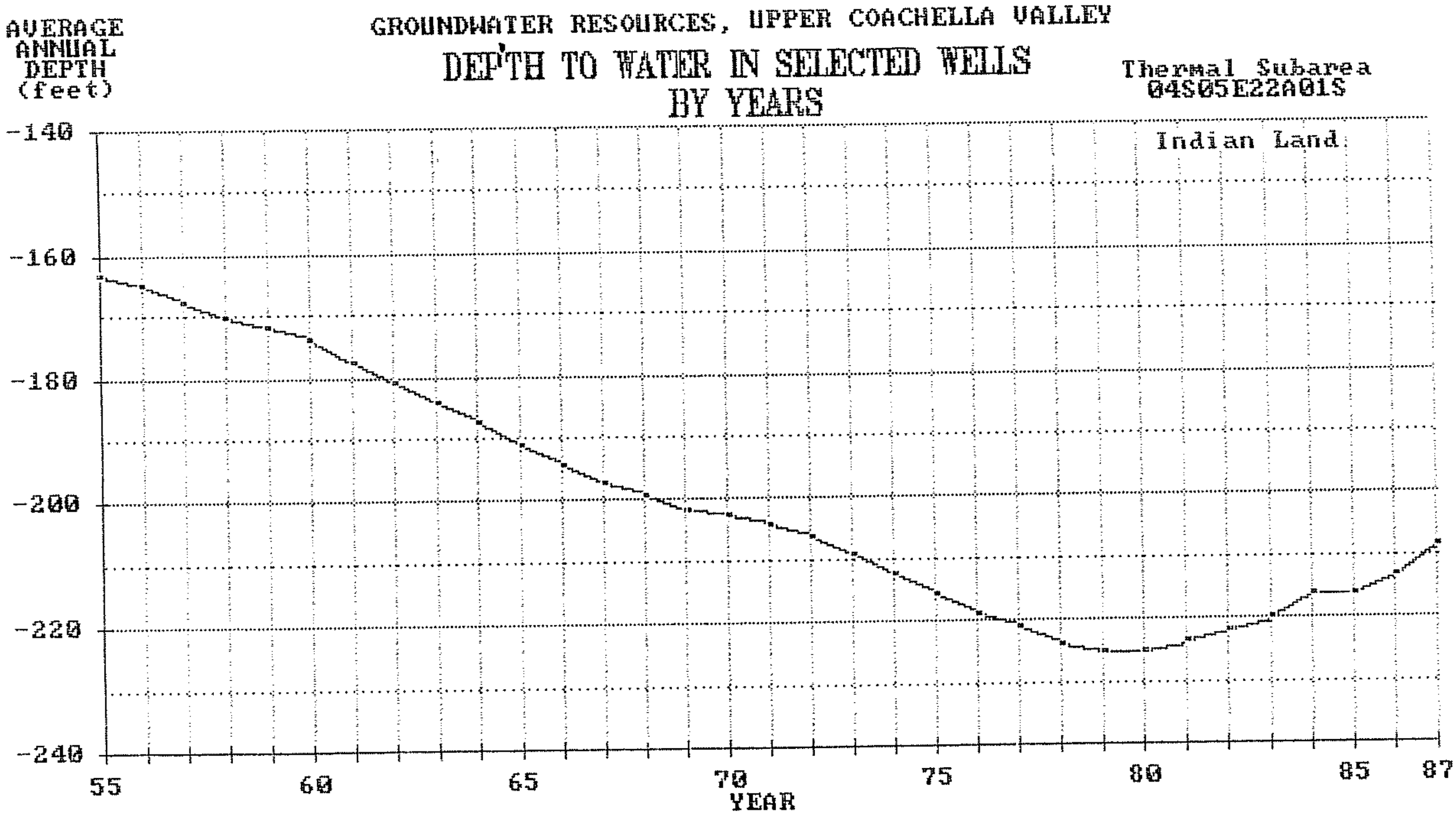
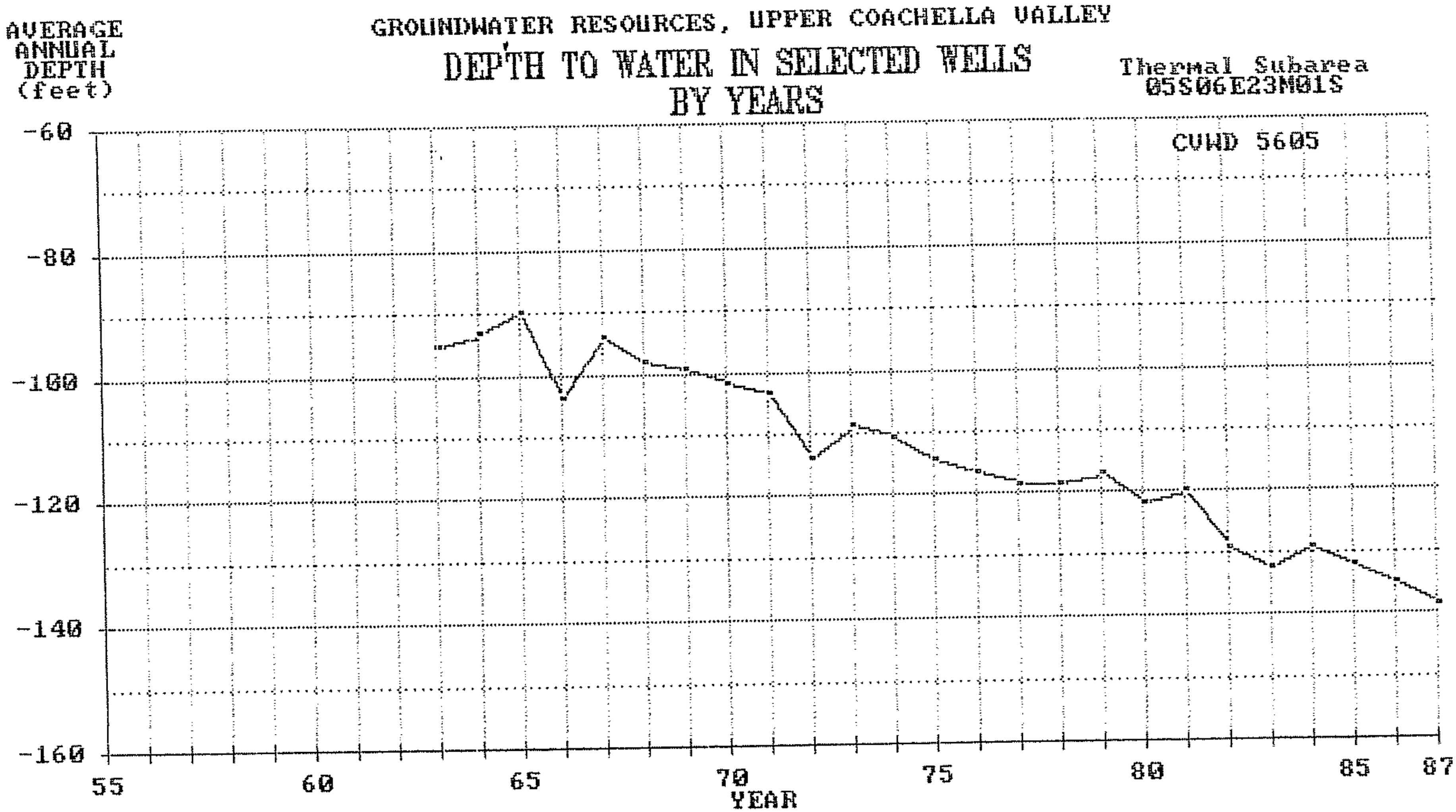

GROUNDWATER RESOURCES, UPPER COACHELLA VALLEY
DEPTH TO WATER IN SELECTED WELLS
BY YEARS
Thermal Subarea
04S05E22A01S
Indian Land
AVERAGE ANNUAL DEPTH (feet)
-140
-160
-180
-200
-220
-240
55
60
65
70
75
80
85
87
YEAR

Figure 2a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DEPTH TO WATER IN SELECTED WELLS
BY YEARS
AVERAGE ANNUAL DEPTH (feet)
Thermal Subarea
05S06E23M01S
CWWD 5605
-60
-80
-100
-120
-140
-160
55
60
65
70
75
80
85
87
YEAR

Figure 2b

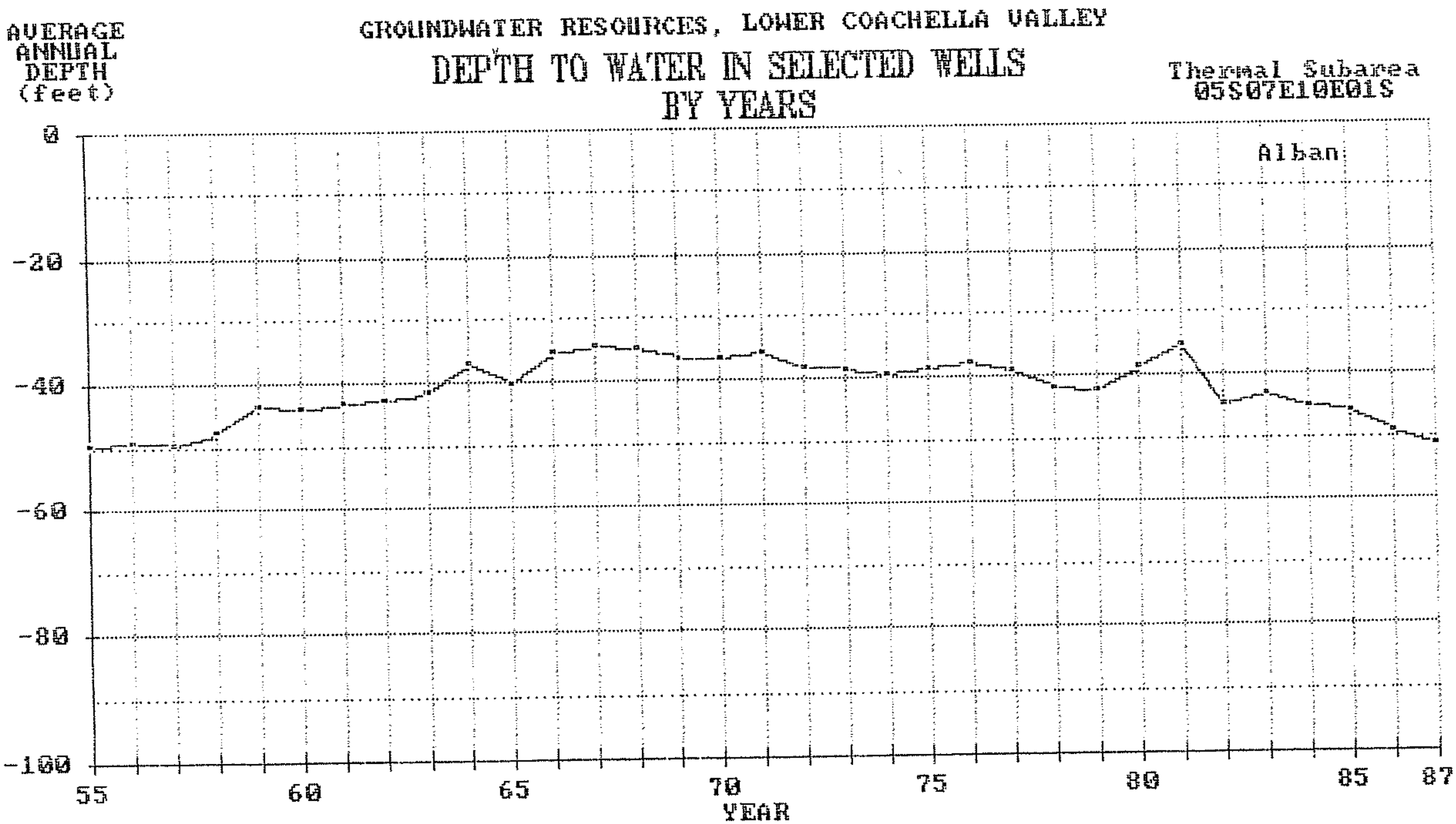
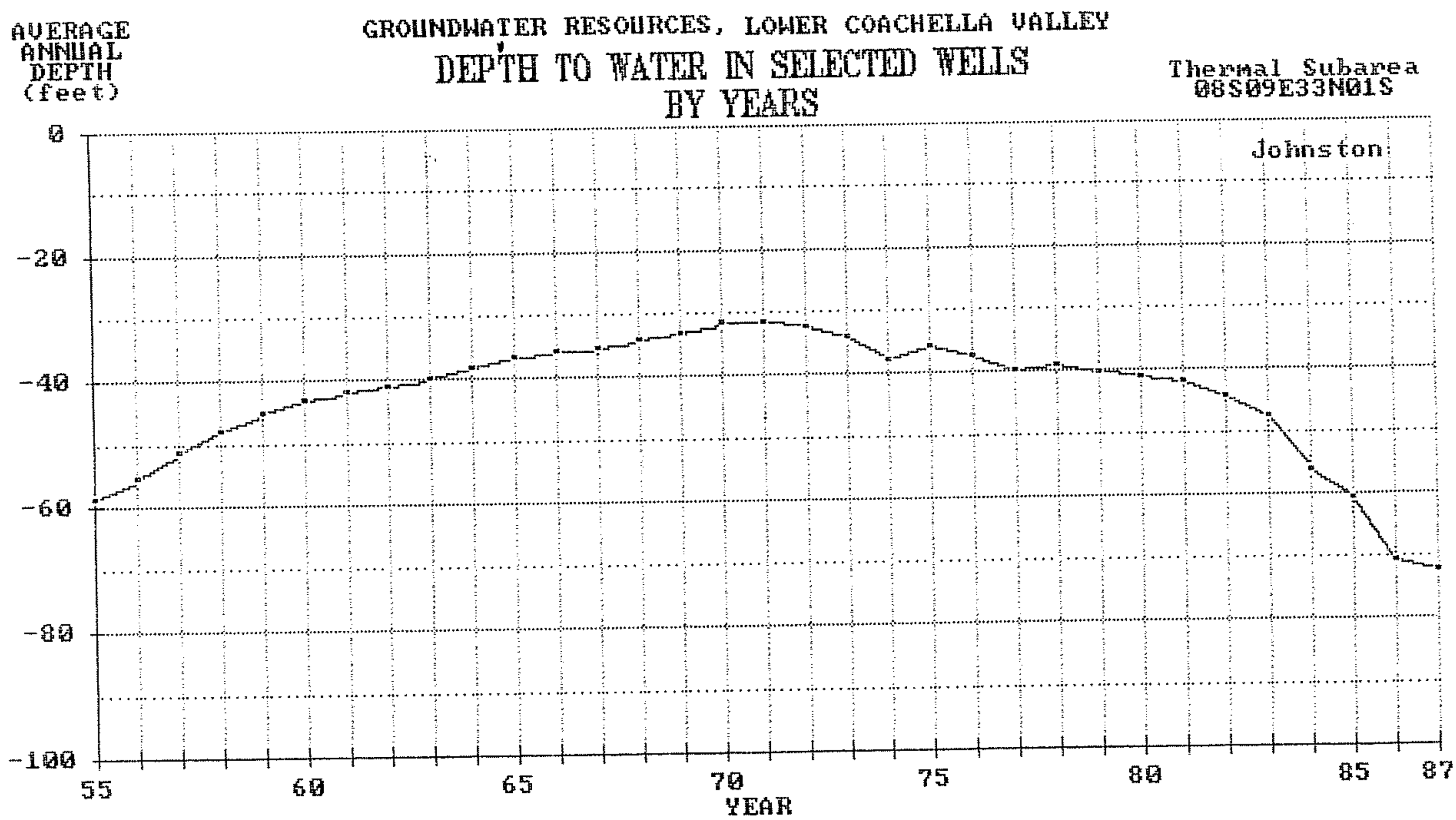

GROUNDWATER RESOURCES, LOWER COACHELLA VALLEY
DEPTH TO WATER IN SELECTED WELLS
BY YEARS
AVERAGE ANNUAL DEPTH (feet)
Thermal Subarea
05S07E10E01S
Alban
0
-20
-40
-60
-80
-100
55
60
65
70
75
80
85
87
YEAR

Figure 3a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DEPTH TO WATER IN SELECTED WELLS
BY YEARS
AVERAGE ANNUAL DEPTH (feet)
Thermal Subarea
08S09E33N01S
Johnston
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-40
-60
-80
-100
55
60
65
70
75
80
85
87
YEAR

Figure 3b

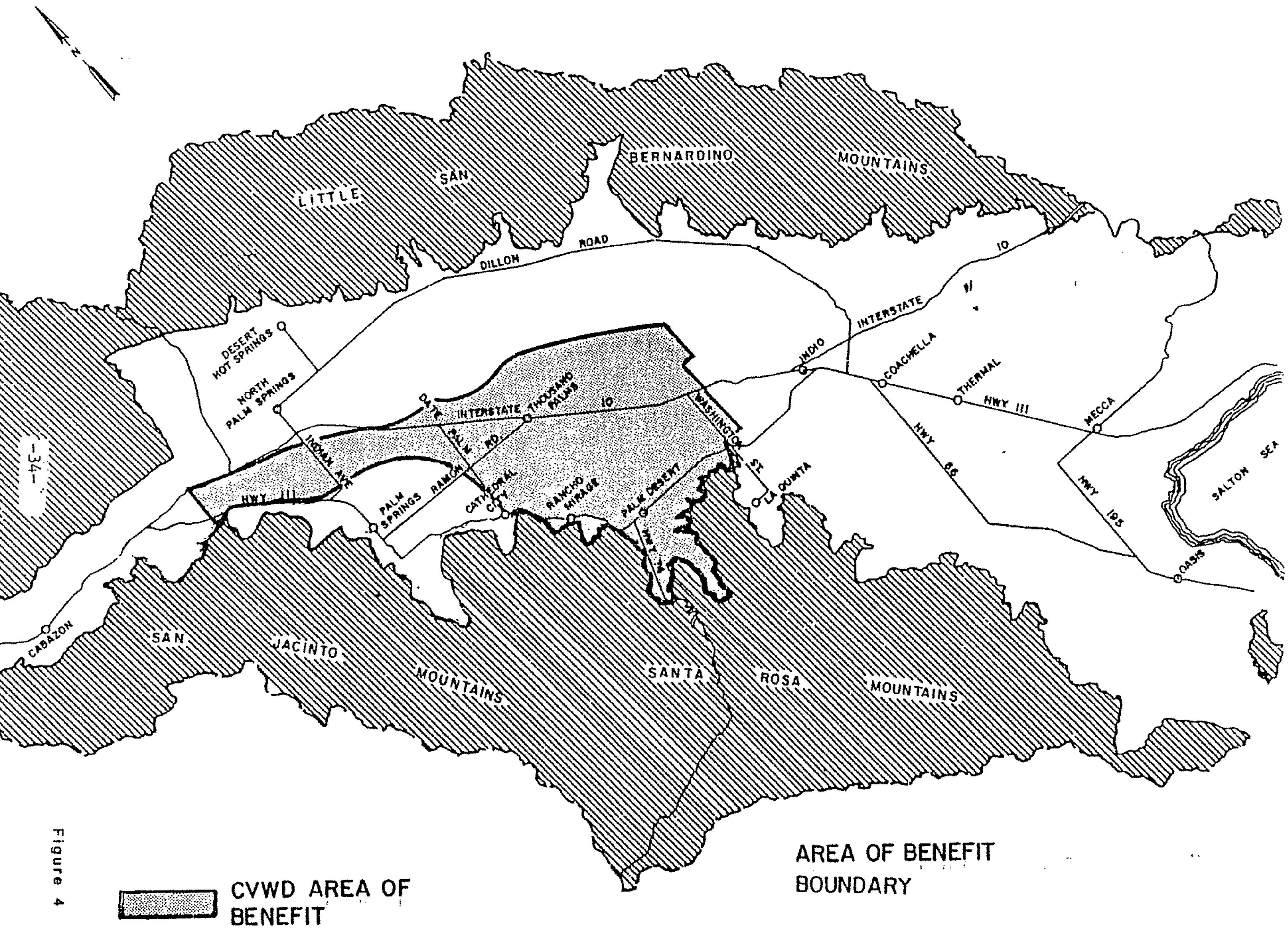
N
LITTLE
SAN
BERNARDINO
MOUNTAINS
DILLON
ROAD
10
INTERSTATE
DESERT HOT SPRINGS
NORTH PALM SPRINGS
DATE PALM RD.
INTERSTATE
THOUSAND PALMS
10
WASHINGTON ST.
INDIAN AVE
HWY 111
PALM SPRINGS
RAMON
CATHEDRAL CITY
RANCHO MIRAGE
PALM DESERT
HWY 74
LA QUINTA
INDIO
COACHELLA
THERMAL
HWY 111
MECCA
HWY 86
HWY 195
OASIS
SALTON SEA
CABAZON
SAN
JACINTO
MOUNTAINS
SANTA
ROSA
MOUNTAINS
AREA OF BENEFIT BOUNDARY
CVWD AREA OF BENEFIT

Figure 4

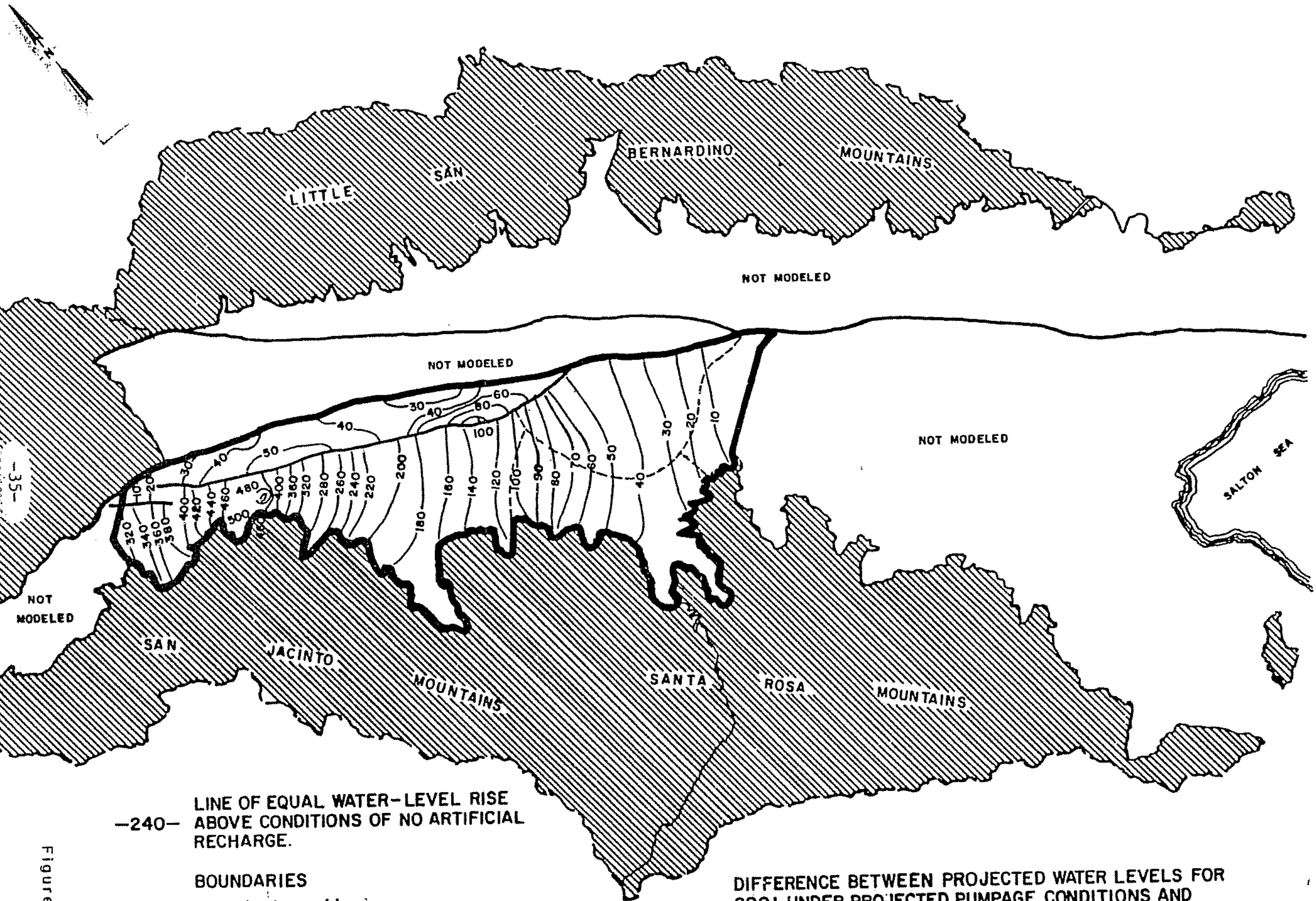

Figure 5

DIFFERENCE BETWEEN PROJECTED WATER LEVELS FOR 2001 UNDER PROJECTED PUMPAGE CONDITIONS AND ARTIFICIAL RECHARGE COMBINED WITH PROJECTED PUMPAGE CONDITIONS. (DRAWING BASED ON TYLEY & SWAIN, 1977)

APPENDIX B
TABLES

TABLE 1

GROUNDWATER STORAGE - COACHELLA VALLEY GROUNDWATER BASIN*

Area	Storage (Acre-Feet)	
San Gorgonio Pass Subbasin	2,700,000	
Mission Creek Subbasin	2,600,000	
Desert Hot Springs Subbasin	4,100,000	
Garnet Hill Subbasin	1,000,000	
Subtotal		10,400,000
Whitewater River Subbasin		
Palm Springs Subarea	4,600,000	
Thousand Palms Subarea	1,800,000	
Oasis Subarea	3,000,000	
Thermal Subarea	19,400,000	
Subtotal Whitewater River Subbasin		28,800,000
Total All Subbasins		39,200,000

* First 1,000 feet below ground surface.

TABLE 2

STATE WATER PROJECT ANNUAL ENTITLEMENTS

AND

COLORADO RIVER WATER EXCHANGES

DISTRICT/DWA MANAGEMENT AGREEMENT(1)

Year	District	DWA	Total
1973	5,800	9,000	14,800
1974	6,400	10,000	16,400
1975	7,000	11,000	18,000
1976	7,600	12,000	19,600
1977	8,421	13,000	21,421 (2)
1978	9,242	14,000	23,242 (2)
1979	10,063	15,000	25,063
1980	10,884	17,000	27,884
1981	12,105	19,000	31,105
1982	13,326	21,000	34,326
1983	14,547	23,000	37,547
1984	15,768	25,000	40,768
1985	16,989	27,000	43,989
1986	18,210	29,000	47,210
1987	19,431	31,500	50,931
1988	20,652	34,000	54,652
1989	21,873	36,500	58,373
1990	23,100	38,100	61,200

NOTES:

(1) Acre-feet

(2) Not delivered due to California drought in 1977 and flood damage to spreading area in 1978.

TABLE 3

COLORADO RIVER EXCHANGE

WATER DELIVERED

Year	Colorado River Exchange Water Delivered Acre-feet
1973	7,475
1974	15,396
1975	20,126
1976	13,206
1977	0(1)
1978	0(2)
1979	25,192
1980	26,341
1981	35,251
1982	27,020(3)
1983	53,732
1984	83,708
1985	251,994
1986	298,201
1987	104,372

NOTES:

(1) California Drought

(2) Flood damage to spreading works

(3) Full entitlement not delivered due to Metropolitan Aqueduct pumping capacity and seasonal timing for optimum infiltration.

TABLE 4

PRODUCTION WITHIN THE MANAGEMENT AREA (1)

Year	Groundwater (2)	Stream (3)	Total
1976	81,600	11,400	93,000
1977	86,357	7,000	93,357
1978	86,742	8,530	95,272
1979	102,127	7,801	109,928
1980	116,234	7,303	123,537
1981	120,634	7,822	128,456
1982	116,433	6,512	122,945
1983	118,048	6,467	124,515
1984	142,598	7,563	150,161
1985	151,375	7,143	158,518
1986	156,169	6,704	162,873
1987	170,029	5,649	175,678

NOTES:

(1) In acre-feet

(2) DWA and CVWD combined

(3) Whitewater Mutual Water Company and Chino, Falls, and Snow Creeks

TABLE 5

CALCULATION OF OVERDRAFT IN THE MANAGEMENT AREA(1)

Item	Acre-feet Per Year
Production	-175,678 (2)
Non-consumptive Return (40% of production)	+ 70,271 (3)
Natural Recharge	+ 49,000
Natural Outflow	- 25,000
Groundwater Replenishment based on 1987 entitlement	+ 50,931 (4)
Groundwater from storage (overdraft)	- 30,476
DWR estimated storage (5)	11,000,000 acre-feet
Percentage of overdraft	0.28%

NOTES:

(1) Based on 60% Consumptive Use.

(2) Minus (-) = Outflow.

(3) Plus (+) = Inflow.

(4) Actual recharge for Calendar Year 1987 was 104,372 acre-feet.

(5) First 1,000 feet below ground surface.

TABLE 6

YEARLY PRODUCTION - CVWD AREA OF BENEFIT

Year	Production (Acre-Feet)
1977	67,696
1978	61,172
1979	72,733
1980	84,142
1981	86,973
1982	83,050
1983	84,770
1984	104,477
1985	111,635
1986	115,185
1987	125,229

TABLE 7

CALCULATION OF REPLENISHMENT ASSESSMENT CHARGE FOR FISCAL YEAR 1988-1989

	COST FOR PERIODS 7/1/88 - 12/31/88 (1)	COST FOR PERIODS 1/1/89 - 6/30/89 (2)	TOTAL COST FOR FISCAL YEAR	INCREMENTS OF REPLENISHMENT ASSESSMENT 1988/89	INCREMENTS OF REPLENISHMENT ASSESSMENT 1987/88
ALLOWABLE COSTS:					
Variable operation and maintenance, power, and replacement components of Transportation Charge	$ 395,481	$ 502,366	$ 897,847	$ 7.18	$ 8.05
Delta Water Charge	160,190	169,644	329,834	2.64	2.58
Coachella Valley Water District (CVWD) payments to Desert Water Agency (DWA) for Delta and Variable O.M.P.&R. charged to replenishment assessment program (3)			968,748	7.74	9.18
Estimated allowable 1988/89 replenishment charge			$ 2,196,429		
Estimated allowable replenishment charge / Projected assessable production (acre-feet) =	$2,196,429 / 125,056	=	assessment charge per acre-foot	$ 17.56	$ 19.81
Credit				(5) (1.60)	(4) (.26)
Assessment Charge After Credit:				$ 15.96	$ 19.55

NOTES:

(1) Charges determined from 1988 fixed and variable schedules provided by the Department of Water Resources (DWR).

(2) Charges developed from schedules supplied by the DWR dated June 30, 1987.

(3) Charges developed by applying the CVWD well production proportion to the total Delta and Variable O.M.P.&R. Costs to be paid by CVWD in accordance with DWA/CVWD Water Management Agreement.

(4) As of April 1987, 1,587.4 acre-feet of additional production over the 1986 estimate for the 1986-1987 Replenishment Assessment was estimated as produced in Fiscal Year 1986-1987. This lowered the calculated assessment by 26 cents per acre-foot.

(5) As of March 1988, 10,113.0 acre-feet of additional production over the 1987 estimate for the 1987-1988 Replenishment Assessment was estimated as produced in Fiscal Year 1987-1988. This lowered the calculated assessment by $1.60 per acre-foot.

TABLE NO. 8

COACHELLA VALLEY WATER DISTRICT REPLENISHMENT ASSESSMENT
WELL PRODUCTION DATA - CVWD AREA OF BENEFIT
TOTAL PRODUCER ASSESSMENTS FISCAL YEAR 1988-89

PRODUCER'S NAME	STATE WELL NO.		TOTAL FISCAL YEAR 1988-89 PRODUCTION ACRE FEET (1)	ESTIMATED ASSESSMENT (2) DOLLARS
ADAMS 34 RANCH	04S07E29E01S		921.7	14,710.
	04S07E29M01S		405.4	6,470.
	04S07E29N02S		249.6	3,984.
		TOTAL	1,576.7	25,164.
AIKEN, JAMES & IRENE	04S07E30M06S		90.0	1,436.
		TOTAL	90.0	1,436.
AMERICAN GOLF CORP.	05S06E23E03S		288.7	4,608.
	05S06E24D01S		909.9	14,522.
	05S06E24F01S		719.6	11,485.
		TOTAL	1,918.2	30,615.
ANNENBURG ESTATE	04S05E36L01S		630.6	10,064.
	04S05E36L02S		1,245.5	19,878.
		TOTAL	1,876.1	29,942.
BARAJAS, JOHN H.	05S07E18F01S		311.8	4,976.
		TOTAL	311.8	4,976.
BERKE, WOLF AND THOMPSON	05S06E22M01S		255.3	4,075.
		TOTAL	255.3	4,075.
BLUMBERG, LEWIS F.	04S05E27L01S		387.6	6,186.
		TOTAL	387.6	6,186.
C. V. WATER DISTRICT	04S05E04N01S		1,247.7	19,913.
	04S05E05K01S		72.9	1,163.
	04S05E08D01S		1,641.5	26,198.
	04S05E09B01S		565.1	9,019.
	04S05E09F03S		3,006.8	47,989.
	04S05E25D01S		1,686.7	26,920.
	04S05E26B01S		2,210.8	35,284.
	04S05E27E02S		841.0	13,422.
	04S05E28F02S		2,132.2	34,030.
	04S05E35G04S		376.2	6,004.
	04S05E36M01S		763.6	12,187.
	04S06E18Q05S		311.2	4,967.
	04S06E20M01S		1,013.0	16,167.

(1) ESTIMATED FISCAL YEAR PRODUCTION BASED ON PRECEDING CALENDAR YEAR PRODUCTION.
(2) PRODUCTION TIMES $15.96 PER ACRE FOOT

TABLE NO. 8

COACHELLA VALLEY WATER DISTRICT REPLENISHMENT ASSESSMENT
WELL PRODUCTION DATA - CVWD AREA OF BENEFIT
TOTAL PRODUCER ASSESSMENTS FISCAL YEAR 1988-89

PRODUCER'S NAME	STATE WELL NO.	TOTAL FISCAL YEAR 1988-89 PRODUCTION ACRE FEET (1)	ESTIMATED ASSESSMENT (2) DOLLARS
C. V. WATER DISTRICT	04S06E22C01S	115.3	1,840.
	04S06E28K04S	207.7	3,315.
	04S07E32N02S	299.3	4,777.
	05S05E01L05S	1,305.1	20,829.
	05S05E02B01S	1,472.0	23,493.
	05S05E12J01S	1,764.5	28,161.
	05S05E12L02S	2.8	45.
	05S06E02G01S	2,012.4	32,118.
	05S06E03P01S	1,660.3	26,498.
	05S06E05Q01S	365.9	5,840.
	05S06E06B03S	1,101.7	17,583.
	05S06E06M02S	2,436.8	38,891.
	05S06E06Q01S	372.7	5,948.
	05S06E08M03S	2,093.5	33,412.
	05S06E08N02S	1,507.0	24,052.
	05S06E09E01S	380.7	6,076.
	05S06E09F01S	1,213.7	19,371.
	05S06E09Q01S	2,522.7	40,262.
	05S06E10E01S	1,464.4	23,372.
	05S06E12N01S	1,303.1	20,797.
	05S06E13D01S	14.6	233.
	05S06E13R01S	1,775.3	28,334.
	05S06E14G01S	1,184.5	18,905.
	05S06E16A02S	2,088.3	33,329.
	05S06E17G02S	2,528.3	40,352.
	05S06E18R02S	1,929.0	30,787.
	05S06E21N02S	841.4	13,429.
	05S06E21P01S	.5	8.
	05S06E21Q03S	686.7	10,960.
	05S06E22B02S	2,659.4	42,444.
	05S06E23M01S	862.2	13,761.
	05S06E24G01S	1.2	19.
	05S06E24M01S	1,440.8	22,995.
	05S06E28C02S	4.0	64.
	05S06E29C02S	11.7	187.
	05S06E29M01S	45.7	729.
	05S07E06M01S	152.4	2,432.
	05S07E07P01S	234.3	3,739.
	TOTAL	55,930.6	892,650.

(1) ESTIMATED FISCAL YEAR PRODUCTION BASED ON PRECEDING CALENDAR YEAR PRODUCTION.
(2) PRODUCTION TIMES $15.96 PER ACRE FOOT

TABLE NO. 8

COACHELLA VALLEY WATER DISTRICT REPLENISHMENT ASSESSMENT
WELL PRODUCTION DATA - CVWD AREA OF BENEFIT
TOTAL PRODUCER ASSESSMENTS FISCAL YEAR 1988-89

PRODUCER'S NAME	STATE WELL NO.		TOTAL FISCAL YEAR 1988-89 PRODUCTION ACRE FEET (1)	ESTIMATED ASSESSMENT (2) DOLLARS
CASA DORADO	05S06E22J01S		88.8	1,417.
		TOTAL	88.8	1,417.
CATHEDRAL CANYON COUNTRY CLUB	04S05E28F01S		1,223.3	19,524.
		TOTAL	1,223.3	19,524.
CHAMPAGNE PARTNERS	04S06E28E01S		356.1	5,683.
	04S06E28E03S		362.8	5,790.
		TOTAL	718.9	11,473.
CHAPARRAL COUNTRY CLUB	05S06E08Q01S		966.2	15,421.
		TOTAL	966.2	15,421.
CLACK, WILLIAM	04S07E30E03S		62.0	990.
		TOTAL	62.0	990.
COLLEGE OF THE DESERT	05S06E17M02S		328.2	5,238.
	05S06E17P02S		334.4	5,337.
		TOTAL	662.6	10,575.
DATELAND MUTUAL WATER CO.	05S06E21G03S		68.7	1,096.
		TOTAL	68.7	1,096.
DE ANZA MOBILE COUNTRY CLUB	04S05E34C01S		252.5	4,030.
	04S05E34J01S		249.0	3,974.
		TOTAL	501.5	8,004.
DESERT / R. C. ROBERTS	04S06E34K02S		64.6	1,031.
		TOTAL	64.6	1,031.
DESERT FALLS COUNTRY CLUB	05S06E03L01S		1,828.3	29,180.
		TOTAL	1,828.3	29,180.
DESERT HORIZONS COUNTRY CLUB	05S06E22B01S		234.9	3,749.
	05S06E22G02S		313.1	4,997.
	05S06E22H01S		199.9	3,190.
	05S06E22H02S		182.8	2,917.
		TOTAL	930.7	14,853.

(1) ESTIMATED FISCAL YEAR PRODUCTION BASED ON PRECEDING CALENDAR YEAR PRODUCTION.
(2) PRODUCTION TIMES $15.96 PER ACRE FOOT

TABLE NO. 8

COACHELLA VALLEY WATER DISTRICT REPLENISHMENT ASSESSMENT
WELL PRODUCTION DATA - CVWD AREA OF BENEFIT
TOTAL PRODUCER ASSESSMENTS FISCAL YEAR 1988-89

PRODUCER'S NAME	STATE WELL NO.		TOTAL FISCAL YEAR 1988-89 PRODUCTION ACRE FEET (1)	ESTIMATED ASSESSMENT (2) DOLLARS
DESERT ISLAND COUNTRY CLUB	05S05E01B01S		808.7	12,907.
		TOTAL	808.7	12,907.
DESERT PRINCESS COUNTRY CLUB	04S05E08A01S		984.1	15,706.
	04S05E08L01S		369.8	5,902.
		TOTAL	1,353.9	21,608.
DESERT SANDS UNIFIED SCH. DIST	05S06E16M01S		117.8	1,880.
		TOTAL	117.8	1,880.
DIMARE ENTERPRISES	04S06E25C02S		738.1	11,780.
	04S06E25C03S		292.2	4,664.
		TOTAL	1,030.3	16,444.
EISENHOWER MEDICAL CENTER	05S06E06M01S		910.2	14,527.
		TOTAL	910.2	14,527.
ELDORADO BARRANCA PROP OWN ASN	05S06E23N01S		71.3	1,138.
		TOTAL	71.3	1,138.
ELDORADO COUNTRY CLUB	05S06E27A01S		390.6	6,234.
	05S06E27A02S		147.0	2,346.
		TOTAL	537.6	8,580.
F. S. L. I. C./WHITE SUN RNCH.	05S06E18G01S		36.5	583.
		TOTAL	36.5	583.
GEORGE N. MC RAE	05S07E05K01S		146.2	2,333.
		TOTAL	146.2	2,333.
I. W. ASSOCIATES (VINTAGE)	05S06E27C01S		14.6	233.
	05S06E27C02S		134.0	2,139.
	05S06E27D01S		442.6	7,064.
	05S06E27D02S		572.0	9,129.
	05S06E28E02S		1,196.6	19,098.
	05S06E28H01S		739.8	11,807.
		TOTAL	3,099.6	49,470.
INDIAN WELLS COUNTRY CLUB	05S06E23K02S		946.5	15,106.

(1) ESTIMATED FISCAL YEAR PRODUCTION BASED ON PRECEDING CALENDAR YEAR PRODUCTION.
(2) PRODUCTION TIMES $15.96 PER ACRE FOOT

TABLE NO. 8

COACHELLA VALLEY WATER DISTRICT REPLENISHMENT ASSESSMENT
WELL PRODUCTION DATA - CVWD AREA OF BENEFIT
TOTAL PRODUCER ASSESSMENTS FISCAL YEAR 1988-89

PRODUCER'S NAME	STATE WELL NO.		TOTAL FISCAL YEAR 1988-89 PRODUCTION ACRE FEET (1)	ESTIMATED ASSESSMENT (2) DOLLARS
INDIAN WELLS COUNTRY CLUB	05S06E25A01S		80.9	1,291.
	05S06E25A02S		258.1	4,119.
		TOTAL	1,285.5	20,516.
IRONWOOD COUNTRY CLUB	05S06E32B01S		1,269.5	20,261.
	05S06E32B02S		694.4	11,083.
	05S06E32B03S		76.8	1,226.
		TOTAL	2,040.7	32,570.
JOHN E. WESSMAN	05S06E07M01S		179.2	2,860.
		TOTAL	179.2	2,860.
LA ROCCA CONDOMINIUMS	05S06E21R01S		252.7	4,033.
		TOTAL	252.7	4,033.
LAKE MIRAGE	05S06E07B01S		265.9	4,244.
		TOTAL	265.9	4,244.
LAKES COUNTRY CLUB	05S06E10D01S		1,664.5	26,565.
	05S06E10D02S		1,076.7	17,184.
		TOTAL	2,741.2	43,749.
LOS RANCHITOS MUTUAL WATER CO	05S06E07J01S		62.4	996.
		TOTAL	62.4	996.
MARRAKESH COUNTRY CLUB	05S06E29H01S		457.3	7,299.
		TOTAL	457.3	7,299.
MARRIOTT DESERT SPRINGS	05S06E09B01S		2,030.8	32,412.
		TOTAL	2,030.8	32,412.
MC DERMOTT, COLIN J. & VICKI J	05S06E23L01S		49.7	793.
		TOTAL	49.7	793.
MC DEVEL CO-CLACK & MANDALA	04S07E30L01S		612.0	9,768.
	04S07E30P01S		612.0	9,768.
		TOTAL	1,224.0	19,536.
MISSION HILLS COUNTRY CLUB	04S05E25F01S		1,822.9	29,093.

(1) ESTIMATED FISCAL YEAR PRODUCTION BASED ON PRECEDING CALENDAR YEAR PRODUCTION.
(2) PRODUCTION TIMES \$15.96 PER ACRE FOOT

TABLE NO. 8

COACHELLA VALLEY WATER DISTRICT REPLENISHMENT ASSESSMENT
WELL PRODUCTION DATA - CVWD AREA OF BENEFIT
TOTAL PRODUCER ASSESSMENTS FISCAL YEAR 1988-89

PRODUCER'S NAME	STATE WELL NO.		TOTAL FISCAL YEAR 1988-89 PRODUCTION ACRE FEET (1)	ESTIMATED ASSESSMENT (2) DOLLARS
MISSION HILLS COUNTRY CLUB	04S05E26A01S		1,197.3	19,109.
	04S05E26C01S		1,144.0	18,258.
	04S05E26D01S		1,728.0	27,579.
	04S05E26H01S		1,893.4	30,219.
	04S05E26K01S		993.6	15,858.
		TOTAL	8,779.2	140,116.
MITCHELL, D. H.	05S06E16K01S		182.3	2,910.
		TOTAL	182.3	2,910.
MONTEREY COUNTRY CLUB	05S06E08N03S		904.3	14,433.
	05S06E17F01S		455.6	7,271.
		TOTAL	1,359.9	21,704.
MYOMA DUNES WATER COMPANY	05S07E07F01S		477.6	7,622.
		TOTAL	477.6	7,622.
OASIS COUNTRY CLUB	05S06E14G02S		1,258.0	20,078.
		TOTAL	1,258.0	20,078.
OUTDOOR RESORTS	04S05E22B01S		1,173.3	18,726.
		TOTAL	1,173.3	18,726.
P. D. COMMUNITY SERVICES DIST.	05S06E16N02S		1,318.4	21,042.
	05S06E20F02S		.1	2.
	05S06E20F03S		437.9	6,989.
		TOTAL	1,756.4	28,033.
PALM DESERT COUNTRY CLUB	05S06E13B01S		704.5	11,244.
	05S06E13M01S		764.1	12,195.
		TOTAL	1,468.6	23,439.
PALM DESERT GREENS CNTY CLUB	05S06E05B01S		24.0	383.
	05S06E05K01S		668.3	10,666.
		TOTAL	692.3	11,049.
PALM DESERT RESORTER	05S06E12M01S		302.1	4,822.
	05S06E12M02S		951.4	15,184.
		TOTAL	1,253.5	20,006.

(1) ESTIMATED FISCAL YEAR PRODUCTION BASED ON PRECEDING CALENDAR YEAR PRODUCTION.
(2) PRODUCTION TIMES $15.96 PER ACRE FOOT

TABLE NO. 8

COACHELLA VALLEY WATER DISTRICT REPLENISHMENT ASSESSMENT
WELL PRODUCTION DATA - CVWD AREA OF BENEFIT
TOTAL PRODUCER ASSESSMENTS FISCAL YEAR 1988-89

PRODUCER'S NAME	STATE WELL NO.		TOTAL FISCAL YEAR 1988-89 PRODUCTION ACRE FEET (1)	ESTIMATED ASSESSMENT (2) DOLLARS
PALM SPRINGS CEMETERY DISTRICT	04S05E14N01S		308.9	4,930.
	04S05E15R01S		14.6	233.
	04S05E15R02S		20.4	326.
		TOTAL	343.9	5,489.
PALM VALLEY COUNTRY CLUB	05S06E02D01S		662.0	10,566.
	05S06E02M01S		1,594.9	25,455.
		TOTAL	2,256.9	36,021.
PORTOLA COUNTRY CLUB	05S06E16C01S		300.7	4,799.
		TOTAL	300.7	4,799.
R. M. J. V. (MORNINGSIDE)	05S05E02A01S		821.5	13,111.
	05S05E02H01S		559.5	8,930.
		TOTAL	1,381.0	22,041.
RANCHO LAS PALMAS COUNTRY CLUB	05S06E07R01S		781.3	12,470.
	05S06E18C02S		64.6	1,031.
	05S06E18C03S		313.9	5,010.
		TOTAL	1,159.8	18,511.
RANCHO MIRAGE COUNTRY CLUB	05S06E06C01S		58.0	926.
	05S06E06C02S		1,259.7	20,105.
		TOTAL	1,317.7	21,031.
SAN JACINTO MUTUAL WATER CO	05S06E07C02S		150.3	2,399.
		TOTAL	150.3	2,399.
SANTA ROSA COUNTRY CLUB	05S06E05A01S		527.0	8,411.
		TOTAL	527.0	8,411.
SCHMID, WALTER R. & MARGARET	05S06E21H03S		46.7	745.
		TOTAL	46.7	745.
SHADOW MOUNTAIN COUNTRY CLUB	05S06E29B01S		533.5	8,515.
		TOTAL	533.5	8,515.
SOUTH PACIFIC TRNSPT. CO.	04S05E04F01S		1,098.1	17,526.
		TOTAL	1,098.1	17,526.

(1) ESTIMATED FISCAL YEAR PRODUCTION BASED ON PRECEDING CALENDAR YEAR PRODUCTION.
(2) PRODUCTION TIMES $15.96 PER ACRE FOOT

TABLE NO. 8

COACHELLA VALLEY WATER DISTRICT REPLENISHMENT ASSESSMENT
WELL PRODUCTION DATA - CVWD AREA OF BENEFIT
TOTAL PRODUCER ASSESSMENTS FISCAL YEAR 1988-89

PRODUCER'S NAME	STATE WELL NO.		TOTAL FISCAL YEAR 1988-89 PRODUCTION ACRE FEET (1)	ESTIMATED ASSESSMENT (2) DOLLARS
STATE OF CALIFORNIA	04S05E03P01S		185.8	2,965.
	04S05E11E01S		171.8	2,742.
		TOTAL	357.6	5,707.
STOUFFER HOTEL	05S06E23H01S		30.6	488.
		TOTAL	30.6	488.
SUNCREST COUNTRY CLUB	05S06E05M01S		710.7	11,343.
		TOTAL	710.7	11,343.
SUNRISE COUNTRY CLUB	05S05E12B03S		714.7	11,407.
		TOTAL	714.7	11,407.
SWINGLE, L. FAMILY TRUST	05S06E01J01S		86.4	1,379.
		TOTAL	86.4	1,379.
TAMARISK COUNTRY CLUB	04S05E35Q02S		794.3	12,677.
		TOTAL	794.3	12,677.
TAMARISK GARDENS	05S05E01D03S		306.2	4,887.
		TOTAL	306.2	4,887.
TANDIKA CORP.(DEL SAFARI C/C)	05S06E03H01S		668.1	10,663.
	05S06E03K01S		349.3	5,575.
		TOTAL	1,017.4	16,238.
TENNECO WEST	04S07E31Q03S		98.5	1,572.
	05S07E06B01S		40.0	638.
	05S07E06B03S		188.3	3,005.
		TOTAL	326.8	5,215.
THE SPRINGS COUNTRY CLUB	05S05E01Q02S		834.5	13,319.
	05S05E01Q03S		764.5	12,201.
		TOTAL	1,599.0	25,520.
THOUSAND TRAILS	05S06E01K02S		101.2	1,615.
		TOTAL	101.2	1,615.
THUNDERBIRD COUNTRY CLUB	05S05E11A03S		270.7	4,320.

(1) ESTIMATED FISCAL YEAR PRODUCTION BASED ON PRECEDING CALENDAR YEAR PRODUCTION.
(2) PRODUCTION TIMES $15.96 PER ACRE FOOT

TABLE NO. 8

COACHELLA VALLEY WATER DISTRICT REPLENISHMENT ASSESSMENT
WELL PRODUCTION DATA - CVWD AREA OF BENEFIT
TOTAL PRODUCER ASSESSMENTS FISCAL YEAR 1988-89

PRODUCER'S NAME	STATE WELL NO.		TOTAL FISCAL YEAR 1988-89 PRODUCTION ACRE FEET (1)	ESTIMATED ASSESSMENT (2) DOLLARS
THUNDERBIRD COUNTRY CLUB	05S05E12D01S		37.0	591.
	05S05E12D02S		314.6	5,021.
		TOTAL	622.3	9,932.
THUNDERBIRD NORTH ASSOC.	05S05E01N01S		43.3	691.
		TOTAL	43.3	691.
TRI-PALMS ESTATES	04S06E20L01S		796.2	12,707.
		TOTAL	796.2	12,707.
WASHINGTON FRMS/CLACK-MANDALA	04S06E25J02S		391.6	6,250.
	04S06E25R01S		391.6	6,250.
		TOTAL	783.2	12,500.
WOODHAVEN COUNTRY CLUB	05S06E12Q01S		218.7	3,490.
	05S06E12Q02S		866.8	13,834.
		TOTAL	1,085.5	17,324.
ALL CVWD AREA OF BENEFIT PRODUCTION		FINAL TOTAL	125,055.5	1,995,887.

(1) ESTIMATED FISCAL YEAR PRODUCTION BASED ON PRECEDING CALENDAR YEAR PRODUCTION.
(2) PRODUCTION TIMES $15.96 PER ACRE FOOT

TABLE 9

COMPARISON OF ASSESSMENT CHARGES (1)

Year	CVWD	DWA(2)
1978/79	No assessment	$ 6.81
1979/80	No assessment	$ 9.00
1980/81	$ 5.66	$ 9.50
1981/82	$ 7.43	$ 10.50
1982/83	$ 19.82	$ 21.00
1983/84	$ 33.23	$ 36.50
1984/85	$ 34.24	$ 37.50
1985/86	$ 21.81	$ 31.00
1986/87	$ 19.02	$ 21.00
1987/88	$ 19.55	$ 22.50
1988/89	$ 15.96	N/A (3)

NOTES:

(1) Per acre-foot.

(2) DWA's charges are for any producer pumping in excess of 10 acre-feet per year.

(3) Not currently available.